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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS · AUGUST 14, 1961

WHICH WAY UP...?

IS MAN'S PROGRESS THROUGH THE AGES TECHNICAL OR MANAGERIAL?

HOW ABOUT YOUR PROGRESS?

SEE SPECIAL REPORT ON PAGE 31

UNIVERSITY MICROFILMS
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SALES MAKERS...

Blister Packages of Butyrate Sheet

Shoppers for tools are like shoppers for most things... they reach for merchandise that's quality-packaged to stay factory-new, and clearly displayed for a close look—important factors in self-service. With this thought in mind, Fuller Tool Company began blister-packaging its pliers in sheet extruded of Tenite Butyrate... and sales almost doubled.

Tough and resilient, blisters formed from sheet of Butyrate protect as they display. They are easily assembled to cardboard or other backing by flange-fit, as in the "Slideplax" package for pliers, or by heat-sealing or stapling.

In use, sheet made from Tenite Butyrate has exceptional resistance to impact and its gleaming luster stands up under repeated handling. Butyrate in special formulations also has excellent weather resistance—a factor in the expanding use of the sheet for outdoor signs.

With this array of service properties, sheet extruded from Tenite Butyrate can often be used in thinner gauges than other materials. Economical thermoforming will shape it to intricate detail. And more than 42,000 colors and color effects in Eastman's plastics color laboratory are ready to add extra eye-appeal.

You can get valuable aid in applying Butyrate sheet to your product ideas from an Eastman technical representative. Or, for some helpful literature on the uses of sheet made from Tenite Butyrate, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE®
BUTYRATE
an Eastman plastic

Pliers manufactured by Fuller Tool Co., New York 67, N. Y.: blister-packaged in sheet of Tenite Butyrate extruded by Joseph Davis Plastics Co., Kearny, N. J., and thermoformed by Plaxall Inc., Long Island City, N.Y.

PRODUCT ENGINEERING

McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS

AUGUST 14, 1961

VOLUME 32, NUMBER 33

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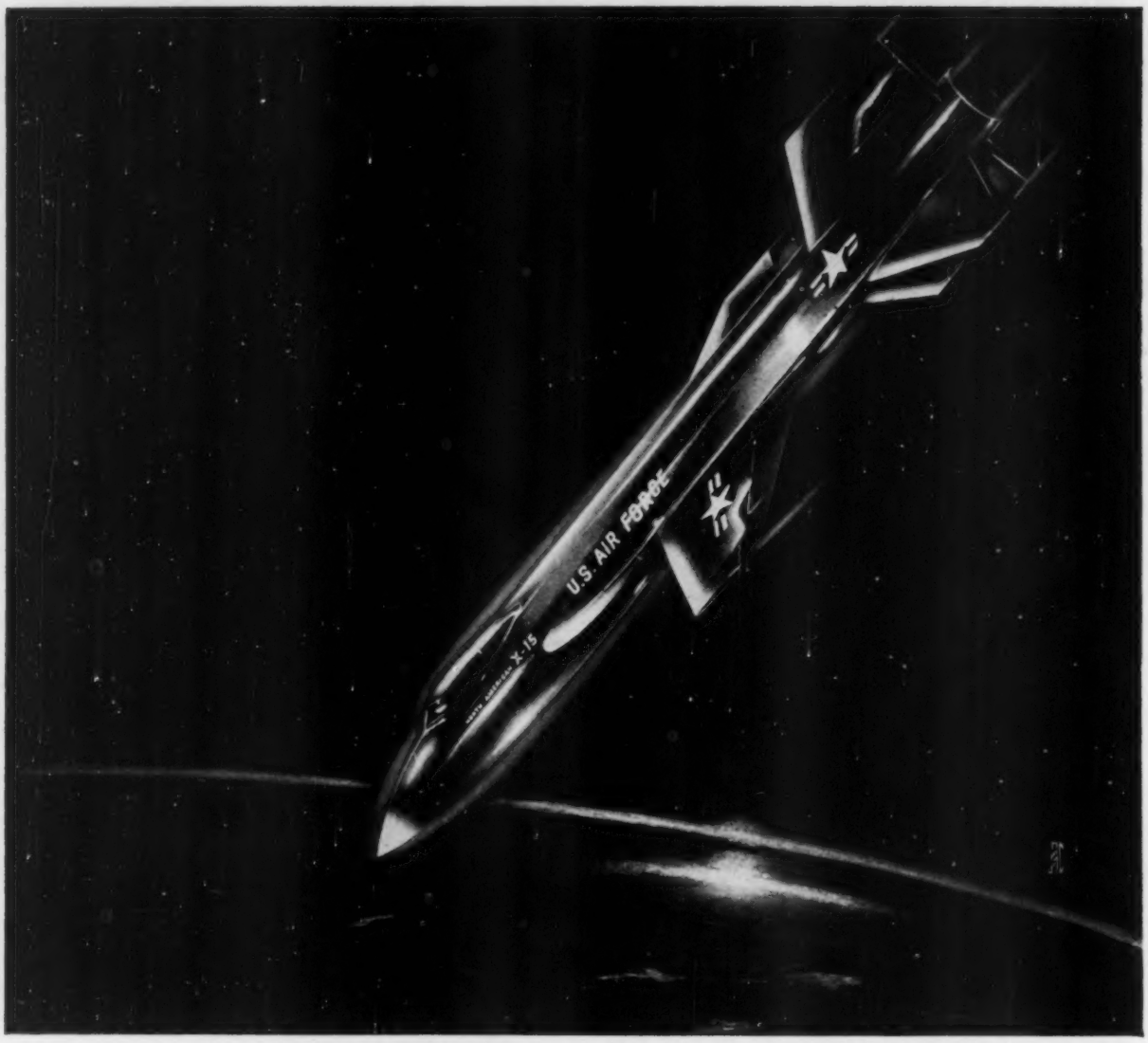
THE COVER . . .
The flow of engineering history through the ages is depicted in this mural planned for Purdue's Freshman Engineering Building. Three-fourths of the rendering is reproduced here. The concept of Prof Philip Best, it is an interpretive presentation of materials and subject matter with which freshman engineers are becoming acquainted, with an underlying theme showing the shift from manpower (to the Crucifixion at the end of Panel 2) through horses to the machine. The final panel is devoted to the Industrial Revolution.

←CIRCLE 173 ON READER SERVICE CARD



In test flight, the X-15, America's first manned space probe ship, has reached a speed of 3370 mph, and an altitude of 169,600 ft. Ship was built by North American Aviation, Inc.

How X-15 survives red-hot re-entry

When the latest pilot-controlled research rocket plane, X-15, streaks in from space to re-enter the earth's atmosphere, air friction heats its nose and leading edges to a blood red heat in seconds.

"Blood red heat" temperatures might easily weaken the skin of the X-15 ... hopelessly soften, deform or destroy many other materials.

How could designers make it possible for X-15 and her pilot to return safely?

The answer was found in an age-hardenable nickel-chromium alloy. Developed by Inco research, it successfully withstands the destructive effect of intense heat. Even when red hot, it retains the strength which the X-15 needs to safely make its re-entry into the atmosphere.

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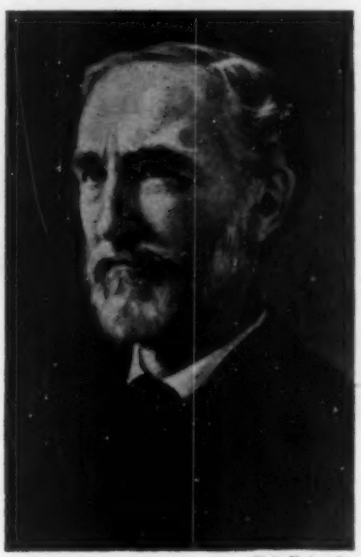
INTERESTING TO NOTE

Yale's shy prof

At a faculty meeting at Yale University many decades ago, professors were engaged in a long, heated discussion about elective courses and the merits of more study in the languages versus more study in mathematics. During a lull in the proceedings, a gaunt, bearded man rose from his chair and in a guarded voice, slightly louder than a whisper said, "Mathematics is a language." These four words made up the entire speech ever delivered by Josiah Williard Gibbs before the Yale faculty. During Gibbs 22 years on the staff he was known as a shy, retiring math teacher—commonly referred to as "poor Gibbs."

In fact when Gibbs was offered the appointment of professor of mathematical physics in 1871 the question of salary never came up. Gibbs was either too shy



Yale University

or too embarrassed to discuss money so for ten years he worked without pay, living on a small family income and occasional fees received from a student he had tutored. It was one of the most economical faculty appointments in Yale's history. In 1881, Johns Hopkins offered him $3000 to join their faculty. Gibbs liked New Haven and told Yale authorities about the offer. They promised Gibbs $2000 a year if he stayed—he agreed.

Gibbs father, also Josiah W. Gibbs, was a professor of divinity at Yale, so it seemed natural that young Willard would attend the same school. The boy was too shy to take the formal entrance examination, so he was asked a few questions by a faculty friend of the family and in 1854 he began his studies. Mathematics was of particular interest to Gibbs and a decade after receiving his doctorate he was teaching his favorite subject.

Professor Gibbs was not only abnormally shy, but also an extremely sensitive man. To him, mathematics could evoke high emotion. One visitor to a Gibbs class reported that, "he stood at the blackboard filling it with equations while tears streamed down his cheeks." He never married, preferring to live with his sisters. One of his pleasures was preparing the salad for the family dinner because "he knew a great deal more about the equilibria of heterogeneous substances than did the others." In 1876 his treatise "On the Equilibrium of Heterogeneous Substances" was published and was the subject of James Clerk Maxwell's lecture in London. Gibbs had developed mathematical laws concerning the transference of heat energy between all possible mixtures of substances. In deriving these laws he adopted statistical methods "and therein inaugurated the whole statistical trend of modern physics and physical chemistry."

In 1894, Samuel Langley was trying to solve some difficult problems in aerodynamics. He wrote to Gibbs asking his advice and received the most elaborate equations for theoretical aerodynamics which had yet been derived. The information was passed on to the Wright brothers and undoubtedly assisted them in their design.

It was Gibb's extreme modesty that kept him apart from public recognition—and probably cost him a Nobel Prize. The work of the shy Yale professor has indirectly aided all of us in engineering. Some old-time Yale men may actually remember Gibbs. Others will long appreciate his contribution to engineering. Engineers—whether technical or managerial (see page 31)—have at some time crossed paths with the theories of Yale's shy prof, Josiah W. Gibbs.

—Benedict A. Leerburger, Jr.

SIDELIGHT

Experiments recently carried out in the UK have shown that drunken mice are better able to withstand radiation than sober ones. The inference is clear—but you may not be able to protect yourself *every night*. In any case science has given formal approval to what may be the most valuable item in a well equipped fall-out shelter.

Typical steam forging hammer

REQUIRED SAFETY FACTORS in steering arm assured by designing it to be forged

By designing with forgings, a truck manufacturer can count on the required safety factors, with minimum "beefing-up" of parts to offset unknown internal structures or non-homogenious materials.

You, too, can achieve results like these by designing *with forgings* either at the start or on re-design. The benefits of forgings are equally impressive, whether you make home-workshop equipment or diesel engines.

Forgings start as *better* metal . . . are further *improved* by the hammer-blows or high pressure of the forging process.

Write for literature on the design, specification, and procurement of forgings.

When it's a vital part, design it to be FORGED

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BUILT-IN BATTERIES may cut the cord to many electrical appliances in the near future.

Rechargeable batteries spawn cordless appliances

St Paul, Minn—Since Jan 1, Gould-National Batteries has sent samples of a new hermetically sealed nickel-cadmium battery to 275 companies for study of possible application in their products.

So far, the batteries have been built into a Remington electric shaver and Black & Decker has announced a ¼-in. cordless electric drill with a 4.8 v battery that produces 2.3 amp-hr. The company says it will drill 300 ⅛-in. holes through ¾-in. fir boards with a single charge. The cells can be recharged 400 times before replacement.

The battery was invented in Europe, but never developed there. In 1953, Gould-National acquired exclusive rights to the unit in the US and Canada. The advantage in sealed batteries is that they are safe (no corrosives can spill out) and easy to maintain. Since then, the company has been working on an R & D program to reduce the size, increase electrical output and evolve manufacturing techniques for the batteries.

HOW IT WORKS

The design is similar to conventional open or vented nickel-cadmium cells: the positive material of the sealed battery is nickel-hydroxide; the negative, cadmium; and the electrolyte, potassium hydroxide. A porous separator prevents contact between metals. But it differs in that precautions must be taken to cycle gases liberated during operation of the cell areas, to prevent rupture of the seal. In cycling, oxygen obtained from the positive electrode during overcharge is channeled through the porous separator to the negative electrode where it oxidizes the cadmium. The resulting cadmium hydroxide is then electrochemically reduced (by the charging current) to metallic cadmium, which again becomes available for oxidation. A delicate balance is required to assure that the rate of evolution does not exceed that of recombination. Hydrogen, obtained from the negative electrode during over-discharge, is handled in much the same manner.

The active ingredients of the electrodes are impregnated in the voids of thin, porous, sintered placque forms. In conventional cells supporting screens hold the compressed oxides in place. The new method of handling active materials gives the unit more resistance to shock and vibration and more energy per sq in. of plate.

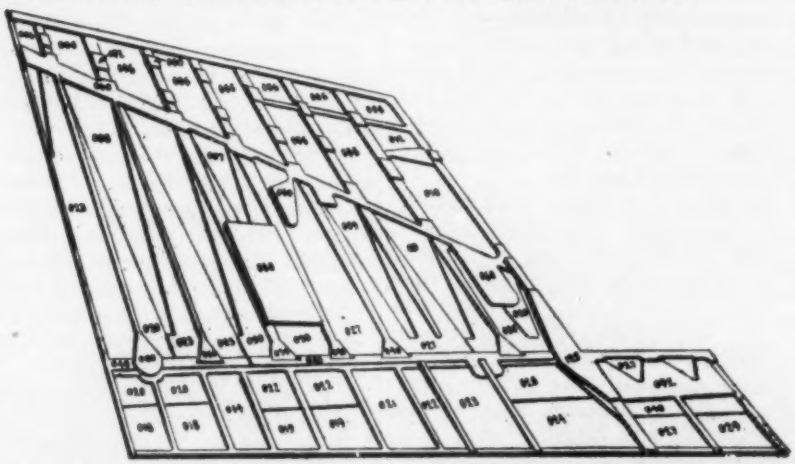
At present Gould-National is making the separator in the battery out of synthetic fibers, but a continuing program of research is under way to find a dielectric material with even better insulation qualities, porosity to allow ionic transfer, and electrolyte absorption qualities.

WHAT NEXT?

At present, units produce up to 15.4 w-hr per lb and 1.6 w-hr per cu in. Through its research program, the company hopes to produce smaller batteries with larger outputs. The biggest cell in operation has 4 amp-hr capacity. Larger cells are planned.

Among anticipated uses for the bat-

Chem milling eliminates welding of complex steel panel



Complex structures can be designed and constructed without weldments, claims Anadite Inc, South Gate, Calif. To prove the point, the company chem milled a steel panel for a supersonic airplane. The 10 by 17 ft PH 15-7 panel has 27 different step thicknesses ranging from 0.140 in. to 0.006 in. Tolerances, says the company, are ±0.001 in.

teries with their present power output are: portable radios, hearing aids, photoflash equipment, and toys. (At company offices, an experimental toothbrush is also on display.) A number of tool room and industrial applications likewise are in the offing: standby-power sources, power supply for test equipment, flashlight cartridges, lantern batteries and control devices. Conceivably, there will also be space applications for running solar powered communications equipment.

–E. H. Seidl, St Paul Bureau

POWER DRILL makes machine repairs—far from energy-giving wall outlet. This is Black & Decker's cordless drill to be marketed soon.

ATT gives NASA rights to its satellite R & D

WASHINGTON—The National Aeronautics and Space Administration has negotiated one of the most far reaching patent agreements ever demanded by the government from industry. It came recently when the space agency agreed to launch up to four experimental communications satellites for American Telephone and Telegraph Co in 1962, probably between April and Oct.

After months of negotiations, the government has agreed to provide launch and tracking service for ATT's experimental satellites with the company paying the space agency $6 million per launch. This is the out-of-pocket cost to the government for the Thor-Delta booster and launch and tracking service. The satellite has been developed, designed and built by ATT at its own expense. Further, the government does not guarantee a successful launch. If the booster should fail or other mishaps prevent the satellite from going into orbit, the loss rests with ATT.

Admittedly, the NASA-ATT agreement is unique because only the government can launch satellites into orbit at this time. And ATT is experimenting in an area where the government's stated policy prevents any single company being dominant.

Nonetheless, the government demanded some unprecedented, far-ranging rights to a 100% industry financed project. In addition to requiring that all data obtained from the satellite experiments be made public, the contract also stipulates that the government has rights to developments made "under any other ATT-sponsored research, which has as one of its purposes advancement of the state-of-the-art in communications satellite systems, equipment components, or ground tracking, transmitting or receiving facilities" made from May 18, 1961 to one year after the last satellite is launched.

The government gets "irrevocable, nonexclusive, nontransferrable and royalty-free licenses to practice such inventions throughout the world by or on behalf of the US, together with the right of the administrator to grant licenses to business entities domiciled in the US under the terms and conditions as the administrator may prescribe, for the practice of such inventions throughout the world in the design, development, manufacture, operation, maintenance, and tracking of communications satellite systems, equipment, components, and ground tracking, transmitting, and receiving facilities."

The nearly spherical ATT satellites will weigh 125 lb, and will be launched into an elliptical orbit having a 600 mile perigee and 3000 mile apogee. Its instruments will be powered by solar cells on the gem-like facets of the satellite's surface. Nickel-cadmium batteries will maintain power during sunless periods.

Among experiments contemplated by the company are a variety of wide-band transmission tests–TV, 2-way telephone, radio and telegraphy–between Holmdel, NJ, and Rumford, Me. The satellites will also carry scientific radiation equipment for measuring damage to solar cells or other solid state components caused by the Van Allen high radiation belts.

In another space announcement, NASA has disclosed details of Project Relay, the $3 million satellite contracted to RCA. Relay will be an 8-sided, barrel-shaped satellite, 26 in. dia and 29 in. high. Its elliptical orbit will carry it 3000 miles from earth at apogee and 900 miles at perigee. Though similar to ATT's satellite, the RCA unit will include different components and, according to NASA officials, the two will give a good idea of what's ultimately needed for a useful communications system.

The satellite will contain two communications transponders capable of transmitting 2-way telephone, TV, and other wideband data. In addition, it will be instrumented to measure intensity and distribution of high- and low-energy electrons and protons, and to measure the extent of radiation damage to diodes and solar cells. Britain and France are participating in the experiments and are constructing ground stations. NASA will also contract ATT and ITT for use of their ground stations.

–Seth Payne, Regional Editor

NSPE reports higher incomes for engineers

WASHINGTON—From the standpoint of salary, engineers in the US continue to improve their status, the National Society of Professional Engineers says. Its biennial survey, covering 24,000 engineers this year, shows that the median income reached a new high of $10,660 in 1960—a 6.6% gain over the 1958 survey.

This increase is reflected at all salary levels, NSPE adds. For 90% of those surveyed, incomes were $7140 or over. This is an increase of $100 over the survey two years ago. Three-quarters of the engineers exceeded $8580, up from $8250 in the previous study. The top 25% earned $13,750 or more, up from $13,620 in 1958.

Best paid jobs, the survey shows, are in the New England and Middle Atlantic states, particularly for engineers at higher professional levels. Median salary in this northeast region was $11,350; in the south, $10,790; in the midwest, $10,670; in the plains states, $9680; in the southwest, $10,090; and in the far west, $10,400.

By type of work, the executive-administrative engineers report the highest median, $13,060; followed by consulting at $11,890. Sales engineers report median earnings of $10,950; teaching, $10,260; R & D, $10,480 and design, $9270. ■

engineering news continued on page 8

Want to be an Executive?

Management is actively looking for engineers who have the desire and ability to become administrators

by
James M. Jenks

In a sense, this is the golden age for engineers. Once buried in corporate obscurity, many of them have emerged today as likely heirs apparent to the big jobs — and the big rewards — of business and industry. One impressive indication of this growth is that money spent in research and development over the past fifteen years has increased six-fold.

Despite this stepped-up activity, however, the once disorganized scramble for engineers seems to have ended . . . at least temporarily. And perhaps it's a good thing. Actually, the more perceptive engineers had always realized that unusually high starting salaries were often illusory. The gap between money being offered beginners and the incomes of experienced men was narrowing rapidly. Further, more and more thinking technical men concluded that even top engineering salaries are low when compared with the remuneration of highly placed general executives.

A Plan to Help the Engineer Succeed

Happily, there is a route to increased incomes that is satisfying to both engineer and company alike. This route leads into *management.* It is no easy road but the rewards are great for those willing and able to follow it.

In the vast, complicated world of business the engineer has much to learn. As a manager his duties will bring him into contact with accountants and buyers, advertising men and salesmen, lawyers and other executives. A strange new set of circumstances confronts him. He must gain confidences and be understanding, learn and instruct, be sympathetic, paternal or commanding as conditions require . . . and all in the midst of a business organization about which his knowledge is limited.

Actually, it comes down to this: To succeed as a business executive, the engineer must learn the art of making decisions quickly and accurately. And this ability is, of course, directly dependent upon knowledge. The "principles" of business—while not as scientific and inexorable as those of engineering—are no less important . . . no less essential to efficient procedure.

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We believe that this little book will help any man get down to bedrock in his thinking; however, there's no cost or obligation for it because—frankly—we've never been able to put a price on it that would reflect its true value. Some men have found a fortune in its pages.

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Large nylon castings now available for heavy equipment

READING, PENNA—A new nylon casting process that opens the way to low-cost production of large, complex shapes has been announced by Polymer Corp here. The nylon is said to have applications in heavy industry to replace metal parts.

Known as "monomer cast" MC nylon, it is said to be comparable to Types 6 and 66 nylon in its chemical and electrical properties, but to have some better mechanical and thermal characteristics. Because of the process, the nylon is free of internal stresses, and parts cast from it, the company says, have less tendency to change shape than injection-molded components. Also, nylon sections have been machined without cracking, indicating an absence of random brittleness.

Resistance to fatigue under stress and vibration is said to be from 2 to 10 times better than Type 66 nylon. And at elevated temperatures, it retains rigidity much better than other nylons.

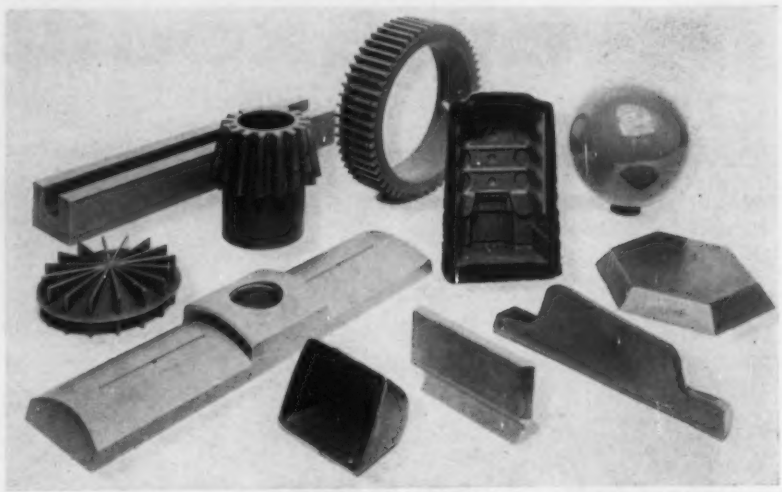
The material can be considered a substitute for stainless, brass or bronze, Polymer says, provided prolonged exposure to temperatures above 250 to 300 F is unnecessary and strong acids are not present. The nylon is considerably less rigid than metal, having an elastic modulus of 300,000 psi.

So far, Polymer says it has successfully tested the nylon in bushings and bearings, gears operating under difficult shock and vibration, valve seats that experience shock loading and in a number of other industrial products.

Castings of the nylon now cost between $3 and $5 per pound. The processing technique is similar to conventional casting of metals: the parts are produced directly from a monomer, rather than powders, thereby halving raw material costs. Unlike other nylon conversion methods, monomer casting is performed at atmospheric pressure. Expensive molds needed in conventional injection or extrusion molding are eliminated.

The basic chemistry for monomer casting was discovered by Monsanto Chemical Co.

Polymer has acquired exclusive rights to the process in the US and other countries and has developed the technology from laboratory scale to commercial production. ■



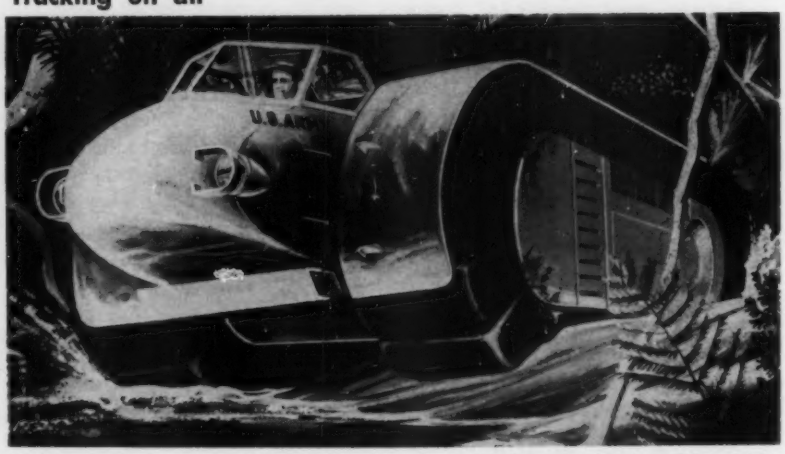
NYLON SHAPES are now available to heavy industry as a result of a monomer casting process developed by Polymer Corp. Castings up to 500 to 700 lb have been tried experimentally.

German engineers object to misuse of 'Ingenieur'

BONN—Efforts to protect legally the title "Ingenieur" restricting its use to professionals meeting certain educational requirements are under way here. At present anyone can call himself Ingenieur without repercussions —a fact unknown to most Germans.

Because the Germans have deep respect for impressive titles, the legal loophole opens the way to abuses. Case in point is the garage owner who advertised himself as "Kraftfahrzeugmeister" (master automechanic, a legally protected artisan title) but lost customers when a resourceful neighbor, with no training, called himself Ingenieur. The title sounded much better than automechanic to most Ger-

Tracking on air



Neither water, snow, mud, tundra nor hard-surfaced road will stay this vehicle from completion of its military mission, the Army predicts. Its logistic versatility derives from a continuous track composed of rubber-impregnated cells filled with low pressure air. This air in effect floats the tank-like unit over soft terrain and water. The tracks are kept clean by an air system for blowing mud, dust and snow away. The vehicle also has an endless manifold system that damps bounding movement on smooth terrain. A half-scale test bed is being constructed by Chance-Vought, Dallas. The final full-scale unit is expected to carry a pound of payload for each pound of vehicle and to travel 50 mph on highways, 30 mph on water.

mans in the neighborhood.

In contrast to the US, Germany has two types of "proper" engineering education:

• **Technical universities** (Technische Hohschulen) give students a firm theoretical foundation in mathematics and physics, as well as engineering. As entrance requirements, students must have the "Abitur" (German high school—equivalent to about two years of college in the US) and a year of practical work. The university course takes at least four years, often five or six. Standards for the final exams are identical in all German technical universities. Graduates earn the title "Diplom Ingenieur," a degree comparable to an MS in the states. In contrast to "Ingenieur," the "Dipl Ing" is legally protected.

• **Nonuniversity engineering schools** limit their lectures to engineering subjects, and turn out students who work at engineering but seldom qualify for research or executive positions. As entrance requirements, students must have a "Mittlere Reife" (comparable to the British Certificate of Education—high school up to 16-17 years old) plus two years practical work in industry or three years apprenticeship in an artisan workshop. Studies take at least three years and lead to the title "Ingenieur."

PARLIAMENT MUST ACT

This title is not protected, though there are 84 engineering schools in Germany with 43,500 students that are either operated or approved by the government. Graduates of these schools object to sharing their title with men from schools not meeting government standards, those who got their title from an industrial firm or those who simply adopted it without any formal engineering training.

This plight has induced 23 German organizations including the Association of Engineers, the Federation of German Industries and the Federation of Chamber of Commerce to form the "German Commission for Engineering Education." It is lobbying for legal protection of the title "Ingenieur," and hopes to have a law passed by the new Parliament elected this September.

MEMBERSHIP ONLY DISTINCTION

Until such law becomes effective, the only distinction is membership in one of the major German engineering associations, all of which now accept only graduates from technical universities or government-approved engineering schools or persons who have carried out "independent creative engineering work" for at least eight years prior to application for membership.

—S. McQueen, Bonn Bureau

Type bars replaced by typing sphere in latesttypewriter

Instead of the type bar used in conventional typewriters, IBM's latest unit has all alphabetic characters, numerals and punctuation symbols on a sphere-shaped element. The printing head—measuring 1⅛ in. dia—is mounted on a head-and-rocker assembly which, in turn, is mounted on a small carrier. The carrier moves from left to right while typing. The 88 characters are arranged with 44 characters on each half of the sphere—four rows of 11 characters in each row. Half the sphere has lower case symbols, other half capitals. The sphere has two axes of rotation—one through the poles and another through the equator. Motions around these axes occur simultaneously as the selected character is moved into printing position. Home position is the upper row and in the center of the 11 characters. At selection, the sphere rotates a max of 82° about its axis and about 50° about the equator, prints, and returns to its home position. Key shift rotates sphere 180° to new home position. Print heads can be snapped on and off to change type face. Six faces, including script, are presently available. Ribbon cartridge houses 18 yards of nylon ribbon in a plastic case. Cartridge can be changed without handling the ribbon and cartridges carrying different colored ribbons inserted. Ribbon and type sphere can be changed in a matter of seconds.

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J-22170

New family of interchangeable thermistors coming

Thermistors with guaranteed, identical resistance curves are being readied for commercial introduction in a wide range of sizes by Yellow Springs Instrument Co. The company has been making these 'interchangeable" disk thermistors for its own use for several years, but now plans to market them commercially. And, the company says, they'll be the first and only ones of their type to reach the market. They'll be offered in resistances of 100, 300, 1000, 3000, 10,000, 30,000 and 100,000 ohms at room temperature. These thermistors will follow the same resistance temperature curve from −40 to 300 F within ± 1%, YSI says, so they can be used as sensing transducers or current compensators. Expected price: below $5 (perhaps $3 in quantity).

These bearings show promise for 1000 F and above

At least half a dozen ceramics and cermets now rate consideration for rolling-contact bearings, and an even wider selection is available for sliding-contact applications.

No commercial materials have been developed specifically for use in bearings at 1000 F and above. But, a survey by Battelle Memorial Institute shows that several cemented carbides and cobalt-base alloys should be serviceable under rolling-contact conditions at least to 1300 F. For sliding conditions, nickel-base and cobalt-base superalloys, cemented carbides, some cermets, and a few pure ceramics all look good.

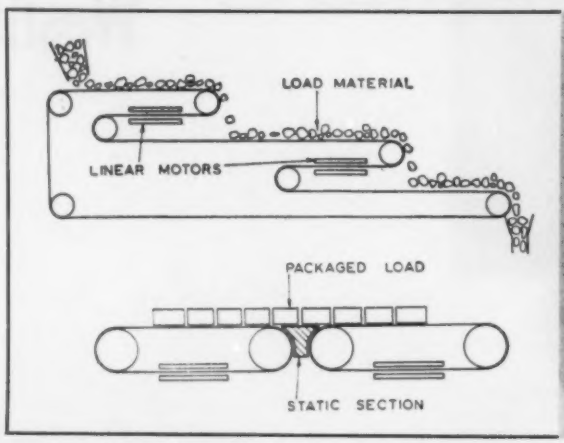
Above 2000 F, intermetallics, graphite, and some ceramics may be considered for potential bearing applications. But graphite, at present, appears to be the only material suitable for sliding-contact applications above 3000 F.

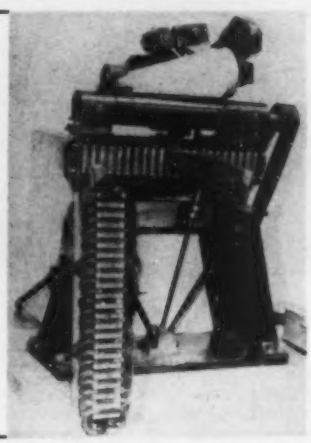
Brass "lubricates" titanium

Antifriction properties of titanium can be greatly improved by applying fairly thick (about 1 mm) brass coatings, Soviet engineers say. They're doing it by first giving the metal a copper flash (not over 30 microns thick), followed by a second, thicker layer. This is then converted to "brass" by packing the part in a mixture of zinc, clay, aluminum chloride and ferrosilicon, and holding it at 1350 F until the zinc diffuses into the copper (about 6 hr). Reporting in *Zhurnal prikladnoy khimii*, (v 33, #12) I. S. Anitov and A. G. Maksimova say parts so coated withstood more than 200,000 revolutions under loads of 1500 psi working against both uncoated titanium and steel.

Flat-armature motors head for new applications

Linear motors that will operate conveyors, and new systems for textile machines, are being developed under the direction of Dr. E. R. Lathwaite at U of Manchester Electrical Engineering Lab. These are motors which have a "flat" armature in place of the conventional rotating cylindrical design. The advantage: space-saving and the possibility of unusual systems, like the one diagramed here, in which the conveyor belt itself is made of conductive material and serves as the "rotor" of the motor.

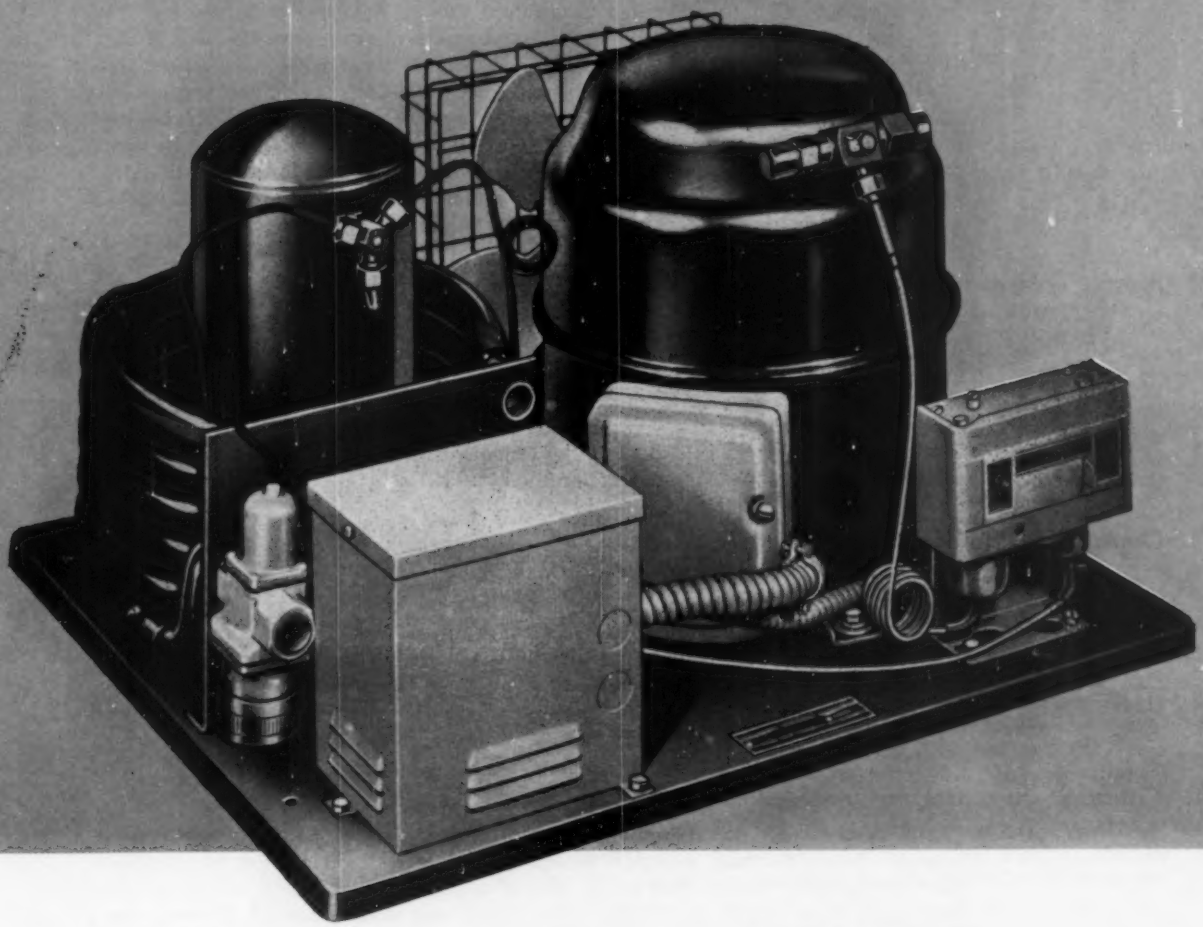




LINEAR MOTORS, applied to conveyor system (left), provide positive drive over a broader area than is possible with conventional motors. In package-winder (right), similar motor is expected to save space, improve operation of transverse mechanism.

continued on page 14

Tecumseh... Producer of Refrigeration Condensing Units... uses Wolverine Tube



WOLVERINE CAPILATOR®—the tiny, precision-made capillary tube for effective metering of liquids and gases – is an important contributor to the success of the hermetic condensing units manufactured by Tecumseh Products Company.

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CIRCLE 13 ON READER SERVICE CARD

Tantalum alloys show high strength at high temperatures

Tantalum alloys with tensile strengths greater than 90,000 psi at 2200 F and good ductility at temperatures as low as −320 F have been produced at Westinghouse Research Lab; and Westinghouse researchers believe they can do even better.

These are tantalum-tungsten-hafnium (Ta-8W-4Hf) compositions. But the Westinghouse researchers (A. L. Feild, Jr, R. L. Ammon, A. I. Lewis, and L. S. Richardson) say several other ternary alloys also show good low-temperature ductility and intermediate to high strength at elevated temperature. Among them, Ta-4Hf-4Mo, Ta-2W-2Re, Ta-4Hf-4Cb, and Ta-4Cb-4Mo. All have room-temperature strengths well above 100,000 psi, and low-temperature strengths in the 150,000 to 200,000 psi range.

The alloys are not without certain drawbacks. Oxidation at temperatures above 2200 F is considered "excessive," so the alloys would need protection in oxidizing atmospheres at high temperatures. Ductility is rather poor, too—only those with very low W, Re and Hf content could be cold rolled. Most could be hot-forged, though, at 2200 F. Test specimens are being made by extruding vacuum-arc melted ingots to sheet bar in a Dynapak machine and then hot rolling (in stainless steel cans).

Plastic spheres will expel fluids to space

Multi-ply Mylar film bladders are under test for positive expulsion of cryogenic fluids in space. Beech Aircraft engineers B. J. Hunter, J. E. Bell and J. E. Penner say, in a report prepared for this week's Cryogenic Engineering Conference, that they've built multi-ply plastic spheres, using ½-mil and ¼-mil laminations, that have withstood as many as 79 operating cycles. They've been tested under zero-g conditions with both liquid hydrogen and liquid nitrogen. Also tested were Dacron-Mylar, nylon-Mylar and Mylar-deerskin combinations; but the multi-ply Mylar looks like the best bet.

Capacitors go king size

Capacitors with ratings as high as 1 farad are being introduced by Tansistor Electronics, Bennington, Vt; and, the company says, a 1-farad, 4-volt unit can be packaged in a box only 4 by 4 by 6½ in. (25 to 50% less space, Tansistor says, than is needed for the collection of units formerly required to meet similar voltage and capacitance ratings). A 50,000-μf, 10-v unit is 2½ x 2½ x 3⅞ in. They're tantalum capacitors with a neutral electrolyte, are hermetically sealed, and can be used over the standard temperature range (to 250 F for the "smaller", 50,000-μf units; 185 F for the larger).

Canada may produce new plastic-rubber blends

Nitrile rubber—polyvinyl chloride blends may get a new boost from Polymer Corp of Canada. Noted for their resistance to flame, weather, and ozone, these blends have been produced in the US. But higher cost, as compared to the unblended plastic has held them back. However, Polymer Corp points out that, unlike PVC alone, the compounds can be vulcanized to minimize plastic flow. At the same time, the blends are superior to the rubber alone in heat, oil, and ozone resistance. Polymer Corp is still studying the question; but expects shortly to reach a decision.

Thermoelectric system records machine productive time

A method for recording productive time that takes advantage of the thermoelectric emf set up between tool and workpiece as heat is generated at the cutting point has been developed by L. M. Ericsson, Erga Div, Stockholm SV, Sweden.

Although the thermoelectric emf is only a few millivolts, and can not be used to provide quantitative information on feeds and speeds, it does provide positive proof that work is taking place, and so can be used for supervision of machine processes.

In the Ericsson unit, the thermoelectric emf is picked up from the machine by a fixed terminal (if the tool is more or less stationary); and, from the workpiece holder, by means of a conventional collector ring with brushes. (Oil films in journals and gears, Ericsson says, prevent short circuits through the machine itself).

An electronic amplifier can be used to complete the system and feed the signal to conventional recording equipment. But units of this type depend on the direction of the emf and have to be tried out for polarity when the workpiece material changes, so Ericsson now prefers a galvanometer-and-photocell arrangement. —ARG

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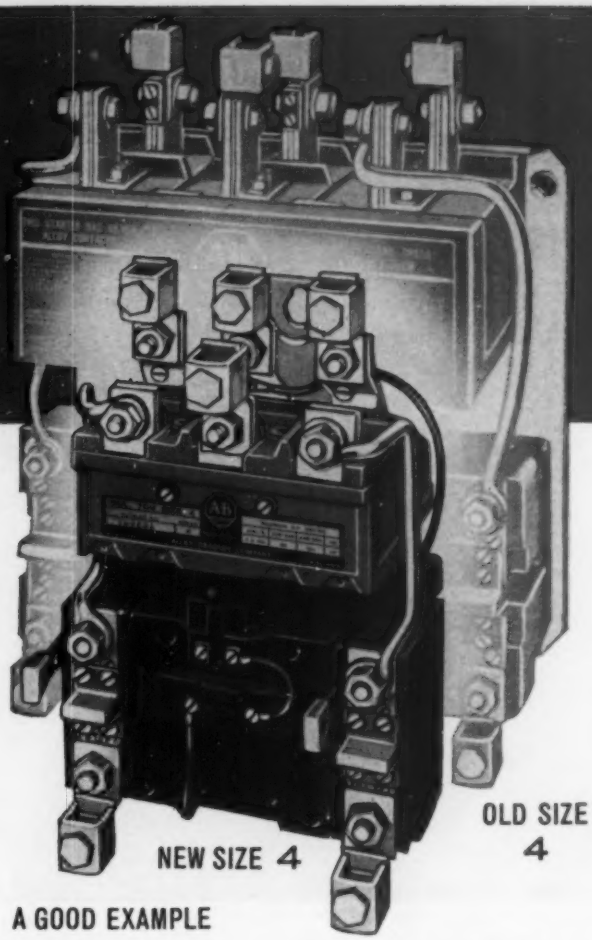
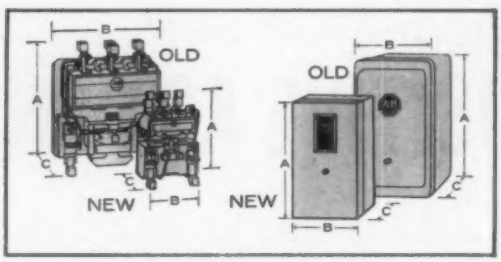


A GOOD EXAMPLE



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	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD
00	4 1/8	—	3 7/8	—	3 1 1/16	—	7 1 1/16	—	4 7/8	—	4 1/2	—
0	5 7/8	5 5/8	4 1/8	4 3/4	3 1 1/16	3 1/4	9 3/16	7 7/8	6 5/16	5 5/8	4 5/8	4 1/4
1	6 5/8	5 7/8	4 5/8	5	3 1 1/16	3 1/4	10	8 1 3/16	6 1 3/16	6 3/8	4 5/8	4 1/4
2	7 5/8	10 1/16	4 5/8	5 3/4	3 1 1/16	4 7/32	12	14 1/2	7 5/8	9	4 5/8	5 7/16
3	10 1/4	12 5/8	6 1/4	7 1/4	5 7/32	5 7/16	16 5/8	19 1/2	10 3/8	11 3/8	7 1/4	6 1 1/16
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5	15 3/8	20	9 1/2	16 1/8	8 5/8	8 3/4	32 7/8	41 1/2	17 3/16	19 3/16	10 1/8	13 3/16

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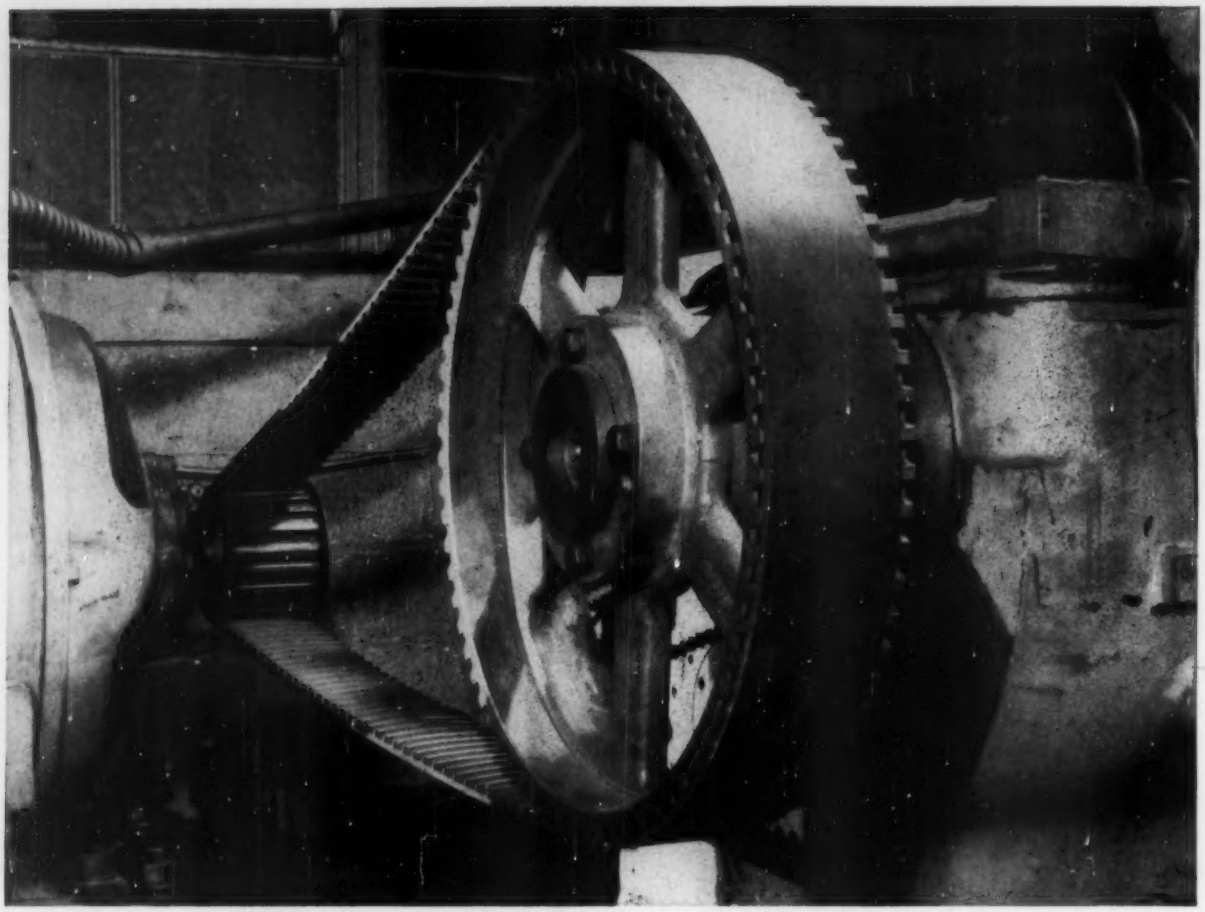

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New route to metal cutting

By taking advantage of the effects of phosphate solutions and other chemically active media on the surfaces of metals, machinability may be substantially improved, a Soviet report declares. Recent findings in this country as well as in the USSR indicate that liquids in contact with metals may have a much greater effect on their physical properties than previously believed (*PE*—May 22, p 6).

Now, V. S. Lapatukhin of Academia nauk says grinding tests on zinc and aluminum, using aqueous phosphate solutions as the coolant, confirm this. Strength and wear resistance of both metals drop sharply when high concentrations of phosphate are used. That means machining rate can be increased and tool wear decreased. With low concentrations, on the other hand (1 to 10 for zinc; 1 to 20 for aluminum), wear resistance increases, and tool life is correspondingly shortened. A report on the tests was published in *Doklady* v 136, #6, 1961.

Rare alloys show unusual properties

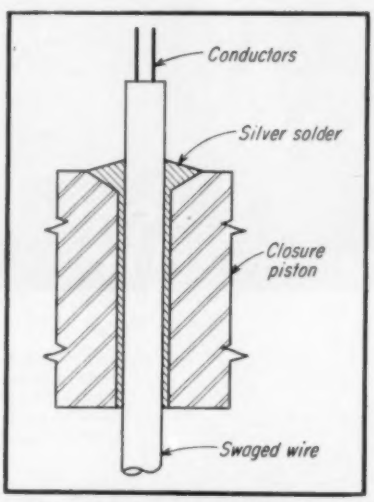
More exotic alloys that look promising for superconducting magnets are reported by Bell Labs engineers. The superconductive properties of rare earth and tungsten-rhenium-hafnium compositions (*PE*—July 10, p 6) have already been noted. Now, BTL has a 50-50 molybdenum-technetium combination that's not only superconductive but may also pave the way for new structural and electrical alloys. Similarities between Tc and rhenium, the BTL researchers say, indicate that Tc may also add strength to molybdenum and improve other electrical properties.

A scandium-indium solid solution that becomes ferromagnetic below 6 K is reported by the same group. Significantly, it was overlooked in previous studies, apparently because the ferromagnetic properties are present in only a very narrow range of compositions. This suggests, the BRL researchers say, that this kind of ferromagnetism may be a more general phenomenon than has been thought and may be found in other systems if a more intensive search is made.

Reports on both studies have been forwarded to the American Physical Society, and additional work is in progress. It should be noted, though, that these exotic metals are exceedingly expensive, and one, technetium, is radioactive and has been made only in small amounts. (It is not found in appreciable quantities in nature.)

This system for electrical hookups to pressure chambers

A simple method for attaching swaged metal-sheathed conductors to pressure chambers is reported by Cornell U researchers. They say all that's necessary to produce satisfactory electrical connections to high pressure chambers is to strip the end of the wire, insert it, up to the sheathed part, in an oversize hole in the pressure piston, and silver-solder it in place. The leads stand pressures in the 4 million-psi range (3 or 4 times as great as leads attached to Bridgman pistons by cementing or silver soldering). The wire may be any one of the commercial resistance materials (Chromel-Alumel, iron-Constantan, Nichrome); the insulation magnesia, alumina, or one of the more-exotic refractory oxides; and the sheath, stainless, Inconel, copper or aluminum. Furthermore, B. H. Cornish and A. L. Ruoff note in a report to *Review of Scientific Instruments*, that the leads are relatively inexpensive (prices are in the $2/ft range) and the system is compatible with pistons which use O-rings for sealing.



METAL-SHEATHED LEADS are soldered into pressure piston as shown here. Conductor dia is about 0.062 in.; hole is 0.0025 in. oversize.

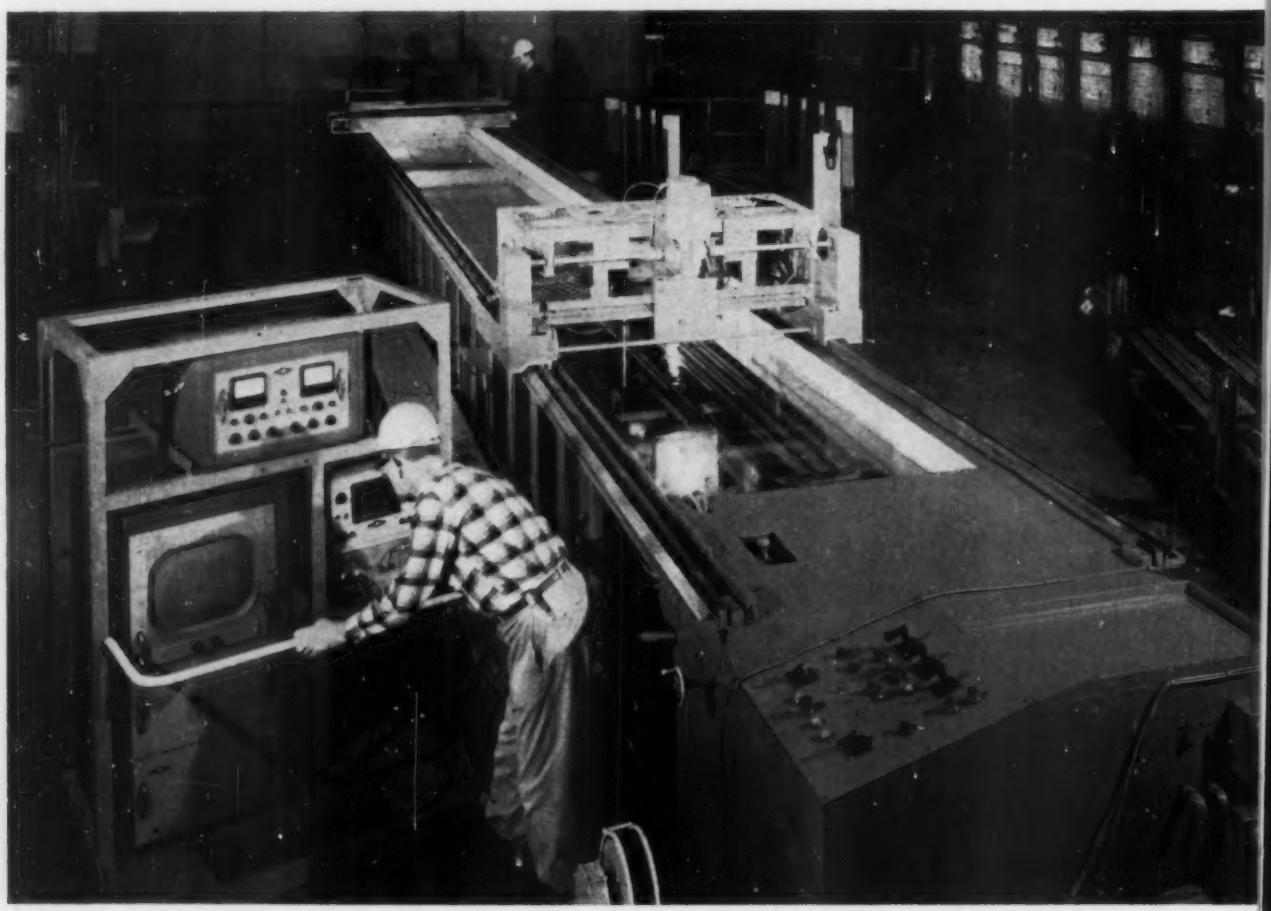
briefs . . .

O-rings for cryogenic service can be used with much lower flange loads than has previously been supposed, NBS cryogenic engineers report. Continuing their studies of elastomers at ultralow temperatures (*PE*—Feb 13, p 6), they've achieved greater simplicity and substantial reductions in required flange loads without sacrificing reliability. They also find that Hypalon (chlorosulfonated polyethylene) can be added to the list of conventional O-ring materials (natural, neoprene and nitrile rubber, fluorocarbon elastomers) that are serviceable in high-vacuum equipment operating at cryogenic temperatures with system pressures to 1000 psig.

Contacts in hermetically sealed relays can "grow" insulation, just by standing in storage, S. W. Chaikin and D. K. Stellman of Stanford Research Institute report. Pure organic vapors and vapors from outgassing in plastic insulation can react spontaneously at some precious metal surfaces to form minute, but significant, deposits of insulating organic polymer. The effect is more pronounced on palladium than gold. The probable reason: deposition is a result of catalytic action, and palladium is a "better" catalyst than gold. A discussion of the phenomenon and the methods used for investigating it is scheduled for the Electron Microscope Society annual meeting later this month.

"Magnetically clean" lab is proving its value in BuShips studies of magnetic fields and magnetic attraction. Designed in West Germany, it's built almost entirely of nonmagnetic materials, is surrounded by an area with a relative permeability less than 1.02. Magnaflux, Inc, which supplied much of the instrumentation, says that a combination of manual and automatic scanners, magnetometers, compensators, timing controls, digital converters and other elaborate sensing devices, makes it possible to obtain accurate magnetic patterns for all sorts of electric equipment. The laboratory is a pioneering installation, the high cost of which (about $200,000) would preclude establishment of very many "carbon copies." But it's expected to provide much data that can be used by designers everywhere. —ARG

What Armco's advanced array and inspection equipment



Bells ring, lights flash and pictures appear on the TV screen when stainless steel bars or billets with subsurface defects are dunked in Armco's "electronic bathtub." It's part of Armco's ultra-modern stainless production and inspection equipment, among the most advanced in the nation.

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THE QUESTION: *What technical problems need solving*

Frank G Daveler
Mgr, Control Components Div
International Resistance Co
Philadelphia

"Inadequate broadbase instrumentation curricula . . . both at the college and technical trade-school levels are our biggest problem. Whereas most engineering specialties are represented in universities with full curricula leading to an appropriate degree and these people are backed up by a wide variety of technical trade-school graduates, the control industry can offer only advanced work at the graduate level. Military control-system groups are populated by mechanical and electronic majors, with the process-control engineer often a chemical engineering major.

"User understanding and maintenance skills are limited. Often a complex control system or component is not trusted because it is mysterious and not as easily understood as purely mechanical devices in which malfunctions are visible. Components may be wrongly applied and mis-used because the system designer is not aware of the limitations or advantages of each of the many basic techniques available. Some are even victims of over-zealous salesmen. These are problems for both user and manufacturer.

"The industry will solve problems in materials limitations, standardization is coming, reliability problems are diminishing, marketing knowledge is growing and new advances in technology are solving our hardware problems. However, a stepped up program of control sciences in our colleges and technical schools is required if we are to capture fully the potential of the future. There must be universal recognition that Control Engineering is worthy of a degree course in our universities, followed by a back-up program of design and maintenance courses at technical trade schools."

"Standardization–or the lack of it . . . in many products in the automatic-control field is one of the most important problems facing our industry. Everyone stands to gain from more standardization–the controls producer, the original equipment manufacturer, the distributors and the dealer-serviceman. These people have all recognized the value of standardized components. The home appliance manufacturer for example, may design his products around a number of interchangeable controls produced by several good companies. This purchase interchangeability results in fewer design and service problems, lower production cost and smaller parts inventories all along the line.

"In more complicated products or systems, however, standardization has made few inroads; in some cases it has not been applied at all. Custom components must be produced–a costly, time-consuming situation which creates obstacles for engineers and servicemen alike.

"Solving the problem of further standardization, I feel, depends to a large measure on action by such trade organizations as the Gas Appliance Manufacturers Assoc and National Electrical Manufacturers Assoc, both of which have made remarkable accomplishments in this field in recent years. As a result of the leadership provided by these groups, together with continued cooperation from both control and appliance manufacturers, I believe more standardization can be achieved throughout the industry."

J F Ray
Vice President Sales
General Controls Co
Glendale, Calif

in the controls industry?

Byron Ledgerwood
Editor
Control Engineering

"Incomplete knowledge of characteristics to be controlled . . .
presents one of the major obstacles to the wider and more efficient application of automatic control systems. The past practice of using many independent single-loop systems to control key end-product parameters, such as chemical composition and sheet-steel thickness, required only minimum knowledge of the static and dynamic process interrelations. But the current objective of directly controlling what you sell, and the desire to optimize process performance, put a premium on the ability to describe process performance analytically. Process analysis and test are necessary to further this end.

"Closely associated with this are two other problems: tests that must be run, and new control schemes that are being experimented with, require measurement of new variables and more accurate measurement of conventional variables. New and more accurate transducers must be developed. At the same time process study often shows ways in which the controlled equipment can be modified to improve its controllability. Hanging control systems on standard machinery seldom leads to an optimum system and sometimes it is disastrous. The equipment or process designer and the control engineer must work together to take maximum advantage of the potential of future automatic control systems."

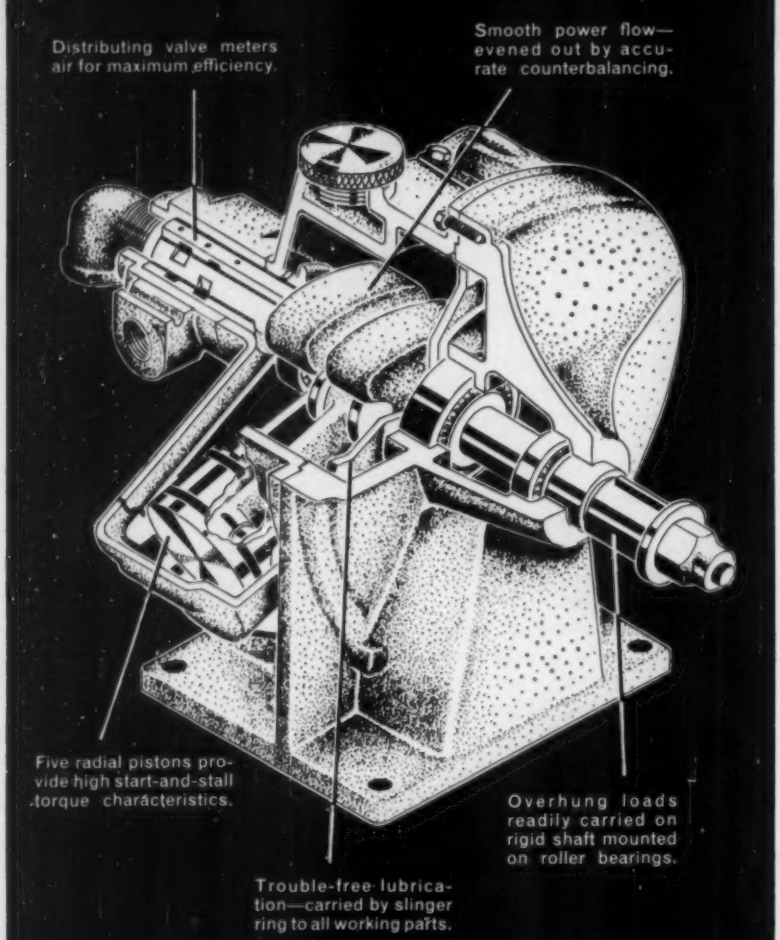
"Control elements must be built-in . . .
to the system from the initial development stages of the program and on into the operational phase. No matter how well we design our gyroscopes, stable platforms or indicators, they must be thought into the system during the advanced design stages if the full benefits, inherent in the latest techniques, are to be realized in system performance.

"This requires a radical change in concept from the old practice of adding controls and other sub-systems after the basic system had been designed. When designing a system we must never forget that the controls are an integral and essential part of that system. This is true today—it will be truer tomorrow. We must ensure that the experimental and developmental phases of the control equipment shall be compatible with the time cycle which includes procurement, processing and production. All phases must be effectively and continually coordinated, from initial design to operational target date, if all the requirements of time, reliability, cost, weight and performance are to be satisfied.

"We must also continue the development of management techniques to monitor and measure program progress, and to ensure that all of our operations are accomplished in the proper sequence with respect to the total program and to each other. We must sharpen our ability to keep abreast of technical advances and be able to convert this knowledge with assurance on a timely basis. The man who is able to correlate all the elements we have discussed, and then to steer a company course or a product plan to success, will be the real superman of the space age."

Joseph M Walsh
Vice President, Lear, Inc
General Manager, Instrument Div

GARDNER-DENVER HIGH-TORQUE
5-CYLINDER RADIAL AIR MOTOR—2 TO 16 H.P.


Distributing valve meters air for maximum efficiency.
Smooth power flow—evened out by accurate counterbalancing.
Five radial pistons provide high start-and-stall torque characteristics.
Overhung loads readily carried on rigid shaft mounted on roller bearings.
Trouble-free lubrication—carried by slinger ring to all working parts.

Look to air power for new design ideas

Gardner-Denver air motors offer positive, instantaneous control . . . continuous operation . . . reversibility . . . no spark hazard . . . can't burn out.

And remember, factory-trained specialists have parts and facilities to keep Gardner-Denver products on the go—wherever they go.

For details, consult your Gardner-Denver air power specialist, or write for Bulletin AM-1.

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Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

READER TO EDITOR

Save ignition coil wear

To the Editor:

While reading my July 10 issue, your news article on page 9 brought to my mind a thought I have had for some time. If a rectifier and resistor of the proper characteristics were connected in series across the primary of the automobile ignition coil the voltage output of the secondary should be more constant for all speeds and there should be very little wear on the contacts through arcing.

The use of a diode would eliminate the need for the condenser. The diode could undoubtedly be designed to have the proper internal resistance, thereby eliminating the need for the series resistor.

—W P West
Leeds & Northrup Co
Philadelphia

Celestial drawing office

To the Editor:

Last night I ate lobster and at half past eleven
I dreamed I had entered an engineer's heaven—
The office was carpeted with luxurious deep pile
And the furnishings were of most unusual style.
Reclining-type chairs were scattered around
And soft hi-fi music made a comforting sound.
Instead of windows, the walls had translucent glass screens
On which one could tune in most exotic scenes.
The guys in the chairs looked like track-and-field champs
So I surmised that the lights must be special sun-lamps.
The gal at the phone desk spoke French, Greek and Spanish
And, I'm telling you fellows, looked anything but mannish:
Her voice, when she called you, was like a sweet song
And her hose, of black net, was slender and long.
I spotted a fountain, not the usual chrome sink,
So I walked over to it to get me a drink:
By pressing some buttons I found I could choose
Refreshments of all kinds (six were good booze).
I thought to myself, this is all very fine
But it still requires work to draw curve or straight line.
So I took up my station quite close to a chair
In which there was seated a guy with blond hair.
Before him was working a drafting machine
Of a type that I never before had seen.
Its stylus was tracing an intricate plan
Untouched by the hand of the fair-haired man.
It seemed that a wire, from a head-set he wore,
Was hooked up to the gadget that stood on the floor.

And, as he relaxed in his upholstered seat,
His thoughts were transmitted through stylus to sheet.
Emitting a low whistle I moved down the aisle
To another engineer who flashed me a smile—
He paused from dictating to answer my query
As to what he was doing, so mysterious and eerie,
To tell me that now he was programming a project
To be completed, alone, by his fabulous gadget.
"This job will be finished by the time I get back:
Tomorrow," he said, "I'm going out to the track."
Now I'm awake and bent over my board—
In my noggin those wondrous ideas are stored.
Already I've drawn a chair—it was tough—
How about you guys designing the rest of the stuff? —GEORGE ASHTON
Los Angeles

COMING EVENTS

AUGUST

22-25 . . . . Institute of Radio Engineers, WESCON Electronic Show & Convention, The Cow Palace, San Francisco

23-25 . . . . American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Utah

28-Sept 1 . . . . American Society of Mechanical Engineers and American Institute of Chemical Engineers; Institute of Mechanical Engineers and Institution of Chemical Engineers (Great Britain), International Heat Transfer Conference, Univ of Colorado, Boulder

SEPTEMBER

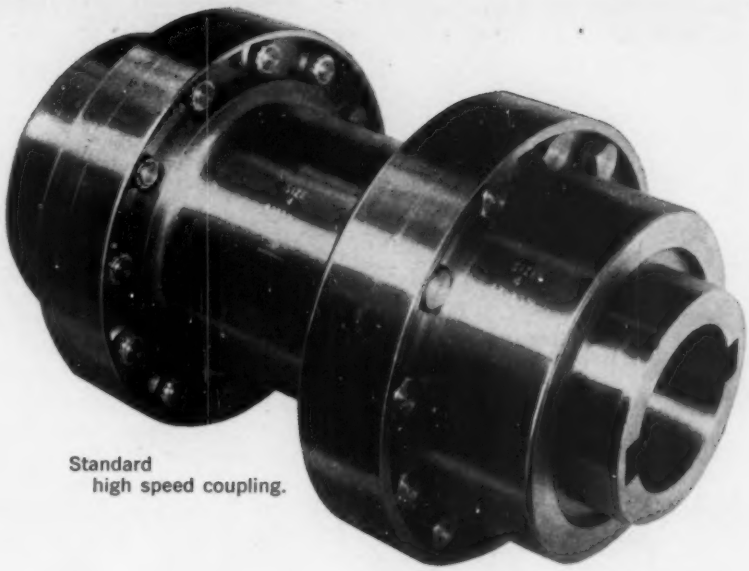
11-14 . . . . Society of Automotive Engineers, National Farm Construction & Industrial Machinery Meeting, Milwaukee Auditorium, Milwaukee, Wisc

14-15 . . . . American Society of Mechanical Engineers, AIEE and IRE, Joint Societies Engineering Management Conference, Hotel Roosevelt, NYC

20-21 . . . . Institute of Radio Engineers, AIEE and ISA, Industrial Electronics Symposium, Bradford Hotel, Boston

25-28 . . . . American Welding Society, Fall Meeting, Adolphus Hotel, Dallas, Texas

For a listing of addresses of societies and associations send 25¢ to Product Engineering Reader Service Dept, 330 W 42nd St, NY 36. Ask for brochure R 32.



Standard high speed coupling.

standard: 20,000 rpm special: 70,000 rpm

Waldron high speed gear couplings are made with special care to prevent vibration—the usual troublemaker at high speeds. All parts are machined and inspected to close tolerances. Every assembled coupling is dynamically balanced on an arbor. Forged alloy steel gives them reliable strength, and they can be furnished grease-packed or continuously lubricated. Write for bulletin S-1500.

Standard size	HP/100 rpm	Max. rpm	Max. bore
1½ HS	19	20,000	1½
2 HS	24	18,000	2
2½ HS	50	15,000	2½
3 HS	87	12,500	3
3½ HS	125	11,000	3½
4 HS	210	9,500	4
4½ HS	305	8,500	4½
5 HS	410	7,500	5
5½ HS	550	6,500	5½
6 HS	675	6,000	6

WALDRON-HARTIG, Box 791, New Brunswick, N. J.
a division of Midland-Ross Corporation MR

WALDRON
Makes it easy to pick the right

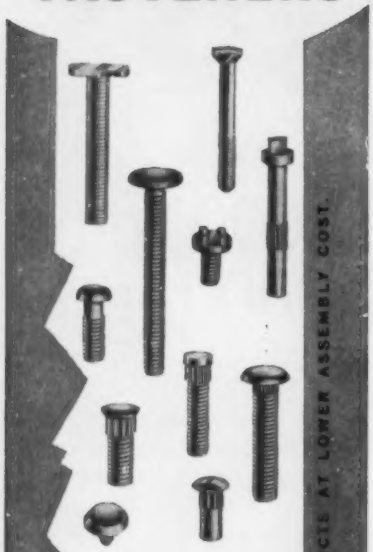
CIRCLE 23 ON READER SERVICE CARD 23

SECURE YOUR PRODUCT QUALITY with

HUBBELL

*COLD HEADED—ROLLED THREAD

FASTENERS



KEY TO BETTER PRODUCTS AT LOWER ASSEMBLY COST.

Hubbell c/h* turns out parts **faster, better** and at **less cost** than screw machining ever could . . . they're **stronger,** more **accurate** and more **uniform.**

Don't be a slave to screw machine waste! Check Hubbell c/h* today. Free part analysis. No obligation.

HARVEY

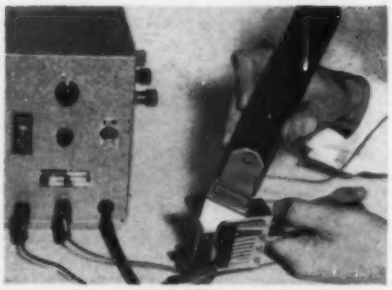
HUBBELL, INCORPORATED

MACHINE SCREW DEPARTMENT

BRIDGEPORT 2, CONNECTICUT

FOR YOUR INFORMATION (personal)

Plating a la carte



PLATING SOLUTION feeds through head of Elektro-Splendor. Metal bracket is anode; workpiece is cathode.

A plating unit that will "do anything"—and do it practically anywhere is being introduced by H. Grieshaber of Zurich. The unit carries its own plating solution in its molded plastic head, connects to any standard circuit through a rectifier supplied with it, and can be used to deposit more than half a dozen different metals (copper, chrome, silver, gold, etc.). You can even vary plating thickness, just by the number of times you brush back and forth. Export price for single units complete with rectifier, 3 bottles of plating solution, and degreaser is $29.90. A fancier model with bath equipment, is $59.35 (fob seaport).

New aid for home fixing

A metal-filled epoxy that can be used to "bond and repair steel, iron, aluminum, bronze, brass, lead, tile, concrete, brick, marble, ceramics, porcelain, wood, glass, leather, fabrics and most hard plastics" is being introduced by Consumer Products Dept, Borden Chemical Company.

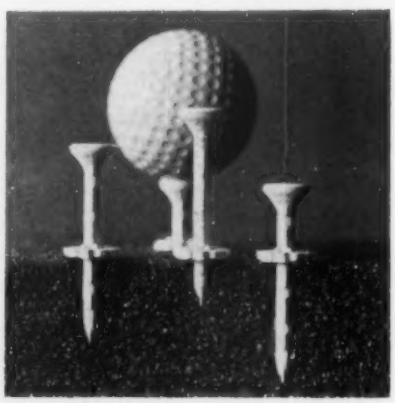
It's a two-part system, which, Borden claims "works equally well in sealing automobile radiators and plumbing fixtures; patching holes in automobile bodies; and anchoring bolts and screws." It sets in 2 to 4 hr. at room temperature and cures "overnight." The price: $9.50 for pint units (resin and hardener); $60.00 a gallon.

These manuals carry their own labs

A series of science kits in book form is being introduced by Science Materials Center. Designed for youngsters in the 8-to-12 age group, the kits are packed in valise-like cartons that open up to display a hard-bound "lab manual" on one side, and a collection of materials to do the experiments on the other.

The manuals are simply written and clearly printed in big type, run to about 48 pages. The lab materials include a variety of simple but interesting items. The magnetism kit, for instance, has ring and bar magnets, compass, iron powder, and various small parts needed to set up tests. A jet engine kit includes a do-it-yourself plastic model; and an air pressure kit has an air pump, plastic tubes, rubber bags and other accessories. SMC calls the kits "Science Book-Labs," has priced each one at $3.95. Publication date: September 7.

Set your tees to size



An adjustable golf tee is the latest answer to the duffer's prayer. Just slip the collar over the point, set it at the proper level, and your ball is at exactly the height you want (see photograph). The collar locks in place with a quarter-turn; unlocks just as easily. Returno Golf Co. molds the tees of tough Tenite butyrate plastic. Cosom Corp., Minneapolis 16, Minn. is the distributor. Price: 25¢ for a bag of 8 tees and collars. —ARG

CIRCLE 24 ON READER SERVICE CARD

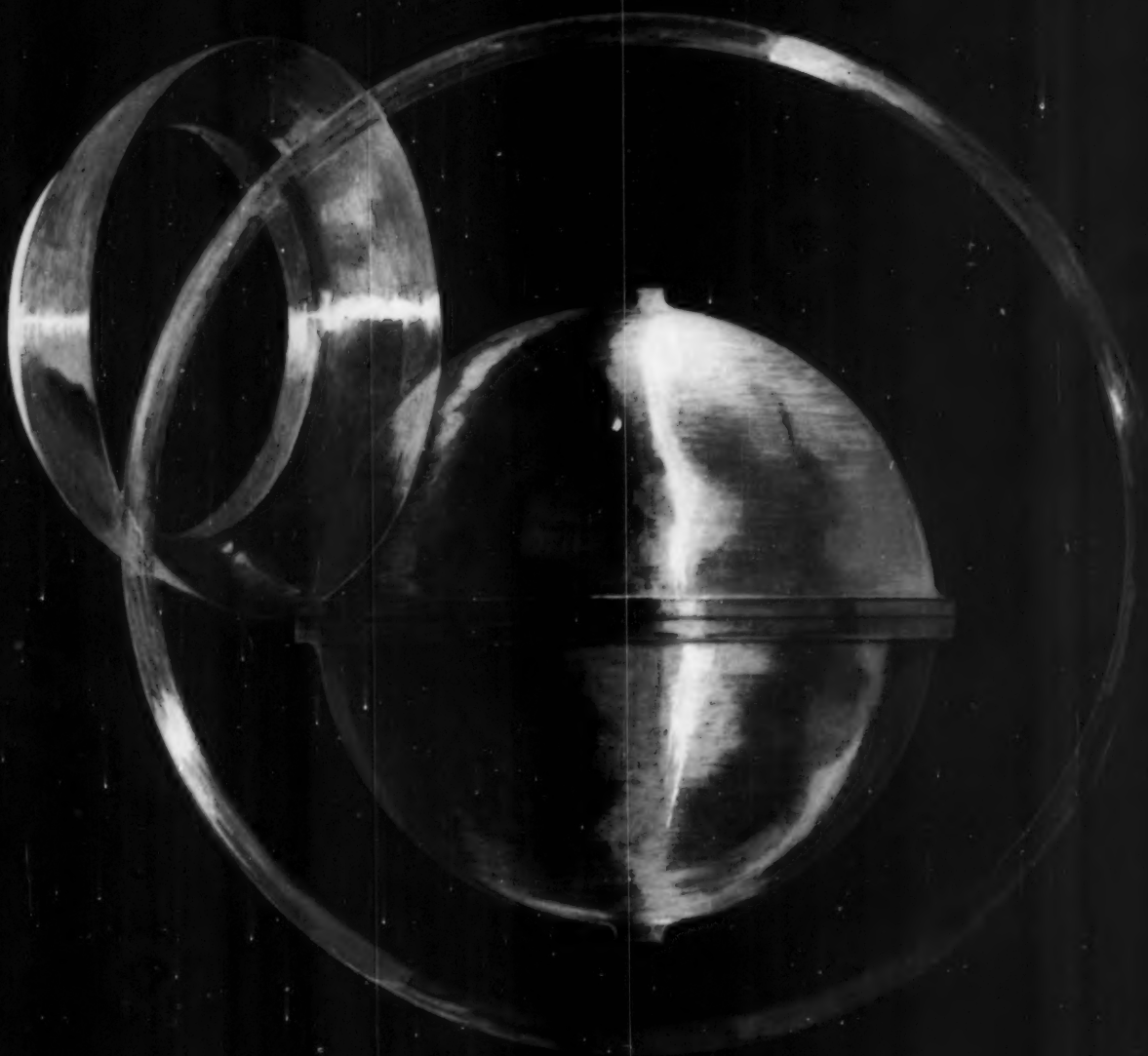
CIRCLE 25 ON READER SERVICE CARD→

What's *your* problem? If it involves forgings, rings or castings for special applications—where high temperature, corrosion or high stress limit the usefulness of ordinary steels—try Standard. We're specialists in superstrength and stainless alloys, and if it's *quality* you want, that's been our hallmark for more than a century and a half.

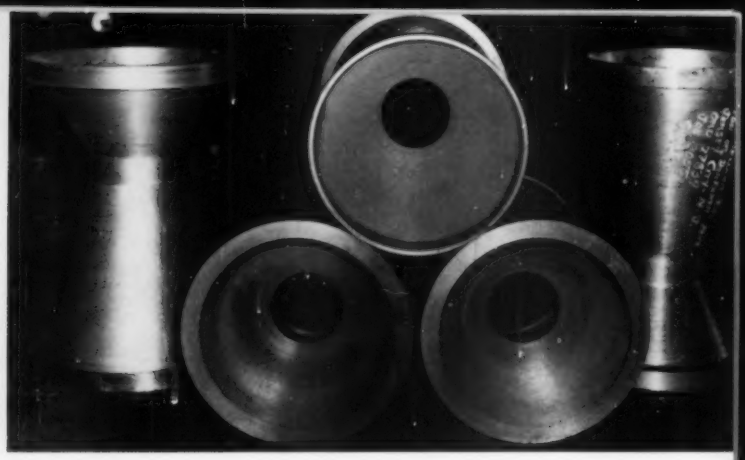
Electric furnace, vacuum degassed steels, vacuum melted alloys, aluminum and titanium are specialties at Standard. We serve leading industries throughout the nation. To name a few just to give you an idea: shipbuilding, rubber, missiles, paper machinery, machine tools, railroads, turbines, large and small.

EXOTIC STEELS

FROM STANDARD

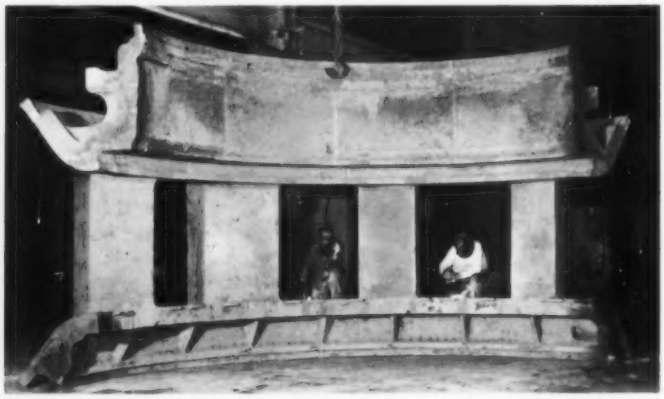


QUALITY CONTROL IS SECOND TO NONE AT STANDARD. Quality control at Standard is maintained by the most accurate, up-to-date testing equipment available. Laboratory facilities operate day and night to support our metallurgists, shop foremen, mill and machine operators—as well as plant management and, of course, our customers.



STANDARD'S OPEN-DIE FORGINGS SUPPLY NATION'S LEADING INDUSTRIES. Steel and nonferrous alloys can be worked in Standard's forge shop, including some hard-to-work metals such as titanium and super alloys. It can turn out forgings from 15 to 52,000 lb.; up to 45 inches in diameter; and up to 60 ft. in length. Major products include rotors and wheels for turbines, propeller shafts for ships, rolls for sugar, printing and rubber industries.

Standard's hundreds of customers represent every major industry in the world. Metal components of carbon and alloy steels, super alloys, and nonferrous alloys such as aluminum and titanium are supplied by Standard for an endless line of products. What particularly impresses our customers however, is the unique, personalized service we provide. See for yourself—bring your next problem to Standard.



STEEL CASTINGS TO VIRTUALLY ANY SPECIFICATIONS. The Standard foundry, one of the larger ones in the country, has turned out castings as light as 1 lb., and ranging up to 85,000 lb. They include some of the largest heads ever cast for dredge cutters and also vital components in huge hydroelectric projects throughout the world. Standard yields to none in the skill of its foundry engineers, metallurgists, molders, coremakers and core setters.

PIONEERS IN ROLL-FORGED RINGS . . . STANDARD. Standard's craftsmanship in forming metal rings for heavy industry dates back to 1856. The first all-forged weldless rings were produced in volume for the first time in 1870—at Standard. And much of the development work in forging weldless rings of high-alloy steels, aluminum and titanium has been done in Standard's Ring Department.

Standard Steel Works Division

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BURNHAM, PENNSYLVANIA

Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes

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Printed in U.S.A.

MI-61-2

One in a series of technical reports by Bower

BEARING BRIEFINGS

TESTING PUTS THE HEAT ON—HELPS BEARINGS BEHAVE IN EXTREME ENVIRONMENTS

In industry today, bearing operating conditions are becoming increasingly severe. To conquer difficult environments, heat, corrosion and oxidation, Bower conducts exhaustive research to achieve improved bearing performance. One important area of Bower research, for example, is the development of special alloys to withstand extreme heat. To do this, Bower researchers use special heating apparatus to study hardness, strength and other characteristics of alloys at temperatures in excess of 1000°F.

Bower engineers study how alloys stretch as temperatures rise in excess of 1000°F., to perfect bearings that can take it.

One of the devices Bower utilizes to assure bearing precision at high temperatures is a creep tester. Bower engineers use it to load a test bar to a predetermined stress level, then, with the assistance of a special heating unit, find out precisely how much the bar stretches as temperatures are elevated to a thousand degrees F., and beyond.

With this type of data and the help of other Bower precision research equipment, engineers can determine alloys that best withstand torrid temperatures. They can also effectively mate thermal expansion characteristics of the various alloys used in roller bearing components and in shafts and housings as well. As a result of this mating, Bower creates bearings that maintain precision in the required temperature ranges and ensures bearings that provide long life, heavy load capacity and high-speed operation.

Because of Bower's continuing research in bearing alloys and other critical areas, we suggest you consider Bower to assist you with your bearing needs. Bower provides a full range of types and sizes in tapered and cylindrical roller bearings as well as in journal roller assemblies. Bower Roller Bearing Division, Detroit 14, Michigan.

BOWER ROLLER BEARINGS

tapered cylindrical journal

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.

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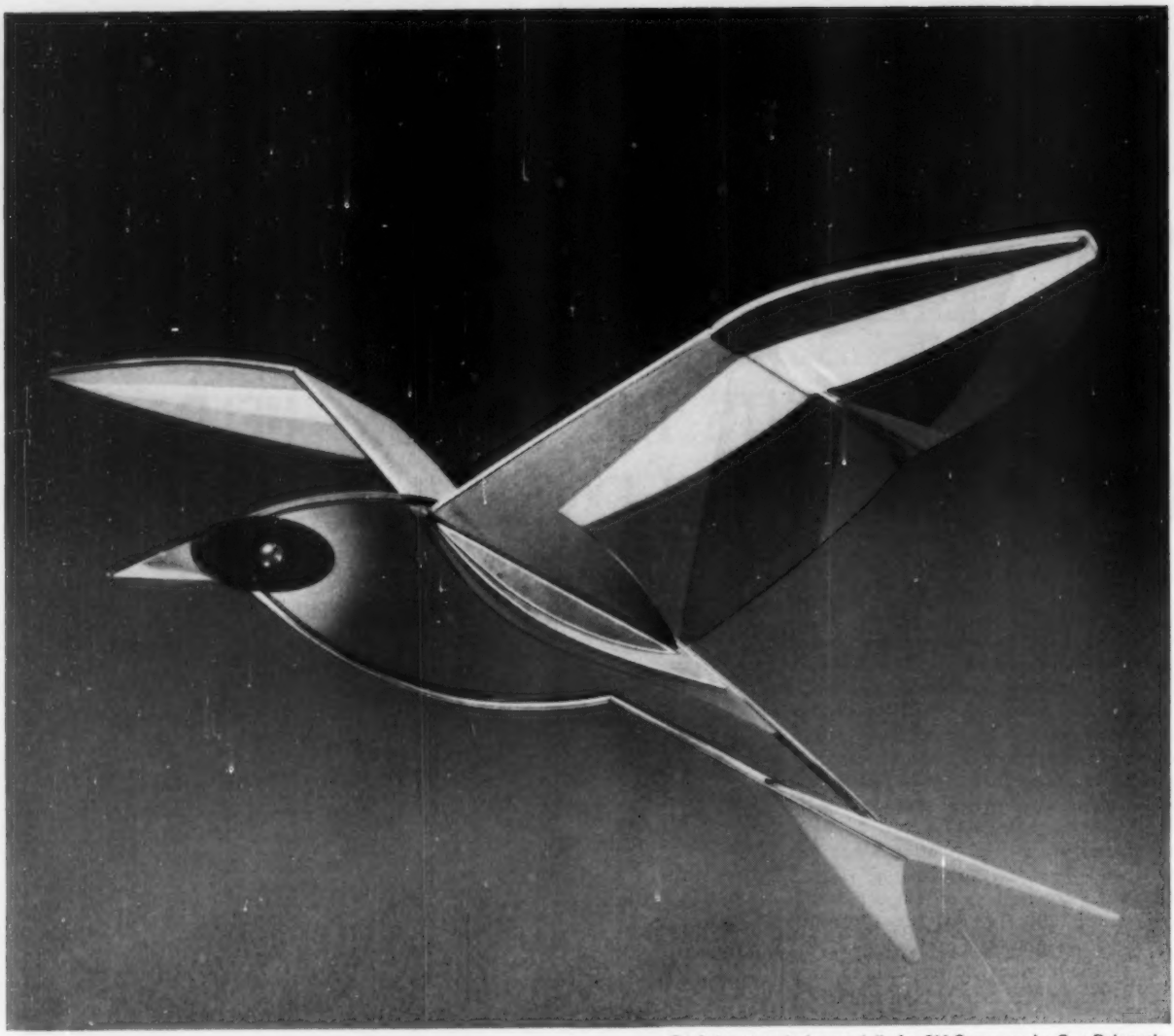

Sculpture created especially for 3M Company by Guy Palazzola

FEATHER-LIGHT...

3M Adhesives help take pounds off today's metalworking products

Reducing dead weight can give a product extra sales advantages . . . make it easier to handle and assemble . . . lower shipping and production costs. The answer: Fabricate with 3M Industrial Adhesives and save weight without sacrificing strength.

In fact, 3M Adhesives often substantially increase the strength of an assembly by distributing stresses evenly over a wide area, making lightweight, high-strength designs possible. And without mechanical fasteners that lower the integrity of the material and cause stress points that tear, fabricators can substitute lighter gauge materials.

For example, 3M Adhesive EC-1357—only one of a complete line of strong, general purpose industrial adhesives—finds wide application in products requiring strength and light weight. It is used in the bonding of metal frames to veneered plywood . . . in honeycomb construction for table tops . . . in sandwich-type wall panels, where it bonds porcelain enameled steel to an expanded glass core.

Backed by a quarter century of research, 3M Technical Service is solving fabrication problems for leading manufacturers in various industries. For an accurate appraisal of how an adhesive can add strength, light weight, production economy, and greater design freedom to your process or product, look first to 3M. Write AC&S Division, 3M Company, Department SBS-81, St. Paul 6, Minnesota.

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What do you want to bond to what?

The Bird is fabricated of these materials and bonded with a variety of 3M Adhesives:

1. Stainless Steel 2. Wood 3. Plastic 4. Glass 5. Brass.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

PRODUCT ENGINEERING HORIZONS

AUGUST 14, 1961

NEGATIVE SERENDIPITY

Serendipity is defined by Webster as "the gift of finding valuable or agreeable things not sought for . . . by chance or sagacity." The word was coined by Walpole in his story, *The Three Princes of Serendip*, but has had little use until the recent emphasis on research. It has been suggested that some men have this gift and some do not, and that this factor accounts for the difference in their results; that acuteness of perception, coupled with soundness of judgment and a sense of relative significance, make some men able to add 2 and 2 and get 6. They know how to associate elements so they together can solve a problem that defies the elements taken individually.

However, B R Stevenson of American Chemical Society points out that this suggests there may also be a **negative serendipity,** the inability to find valuable results because of barriers that prevent chance or sagacious action. If Facts A and B together can solve problem X, which neither can alone, it's serendipity to bring them together. But if Fact A is in the possession of one researcher and B in the possession of another, and they do not interchange, X remains unsolved and negative serendipity triumphs. Then 2 and 2 equal 2.

In a talk at Tucson recently, Colin Sharp relates just such a situation. A West Coast superjet builder was having trouble with Vasco-Jet 1000 heat-treated to 300,000 psi (Rockwell C53). Cutter makers could not help because they couldn't get samples for test. Finally, the plane maker provided some samples and a steel distributor provided scrap ends of the very-expensive material—both free because they needed data. Through tests on these samples, it was found possible to shift from HSS to cast-iron grades of carbide and increase machining speeds from 30 to 100 sfpm.

This is just one example of hundreds in which misplaced secrecy—governmental or company—has allowed a problem to go unsolved, to our general detriment. There is also the reverse problem—when government or company fails to seek out—or even accept when offered—available information that will cut costs and time.

It seems strange that, in this time of technological acceleration, there should still be those who follow a course of bull-headed individuality, wittingly or unwittingly maintained so rigidly that even those interested cannot assist. Such an attitude in the military is traditional; the military resists innovation, while seemingly revealing its secrets only in bars or to some Mata Hari. But it is less understandable, and almost as prevalent, outside. The company that bogs down in its development work through refusal to risk its secrets with qualified, even screened, outsiders, the association that puts a freeze on its members' knowledge, and worst of all the company or individual that rejects available data . . . these are too familiar. They all provide an atmosphere of negative serendipity.

The doctrine of "need to know" currently followed in Washington has its points, in theory at least should reduce the efficiency of the international spy. But we need a contrasting domestic policy of seeking to interchange information that engineers at other companies—supplier or purchaser—can use. Their "need to know" has been proved time and again by their application of new ideas to solve a knotty problem that defies their own experience.

NO STARTING PROBLEMS

with

WAGNER CAPACITOR-START MOTORS

Quick Break Switch

The starting winding is disconnected from the line by this Wagner designed switch . . . test proved to make more than a million breaks. (That adds up to two starts per hour for 50 years!)

Quick Connect Terminals

Brass tabs on terminal studs permit quick, easy connection of leads . . . cut wiring time to speed assembly line production. Simply press the lead receptacle on to the stud—a positive connection is assured.

Pack more power into less space...give long troublefree service...are easy to hook up

Here are general purpose single-phase motors that have high starting torque and high pull-in torque. When used in the proper application and supplied with voltage close to their rating, they'll give positive starts every time. Troublefree operation is assured . . . thanks to the positive action of the Wagner governor mechanism and long life quick-break switch.

Wagner Type RK Motors pack more power into less space. Small enough to fit in tight spots, their ruggedness is built-in . . . permits direct mounting. They are available in a range from ¼ through 5 horsepower, with sleeve or ball bearings, and with rigid bases or resilient mountings. And, sleeve bearing fhp models can be operated in any position.

Get these motors from leading distributors in your city, or from Wagner Sales Offices in 32 cities across the country. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-217 gives full details on Capacitor-Start Motors.

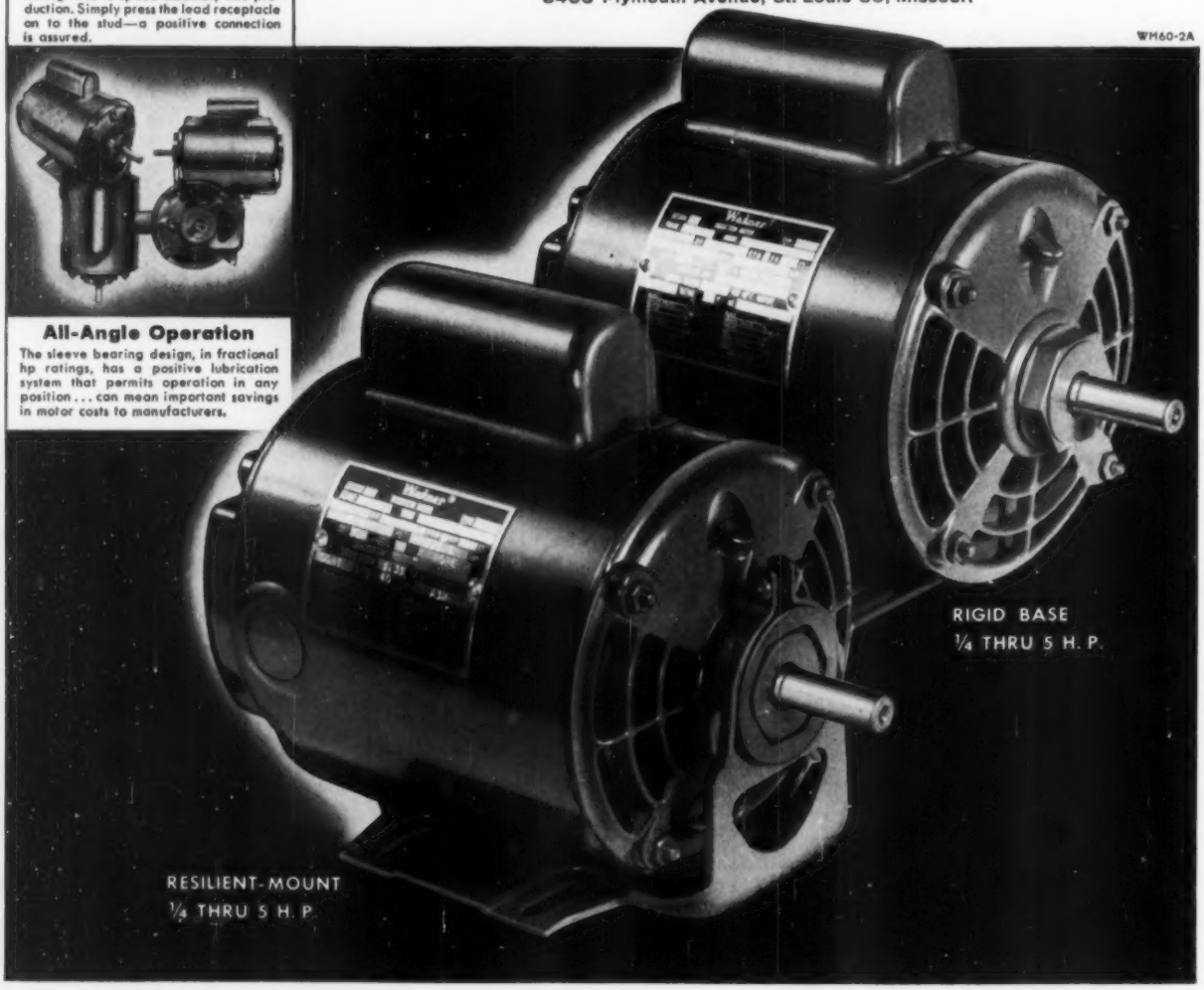
Wagner Electric Corporation

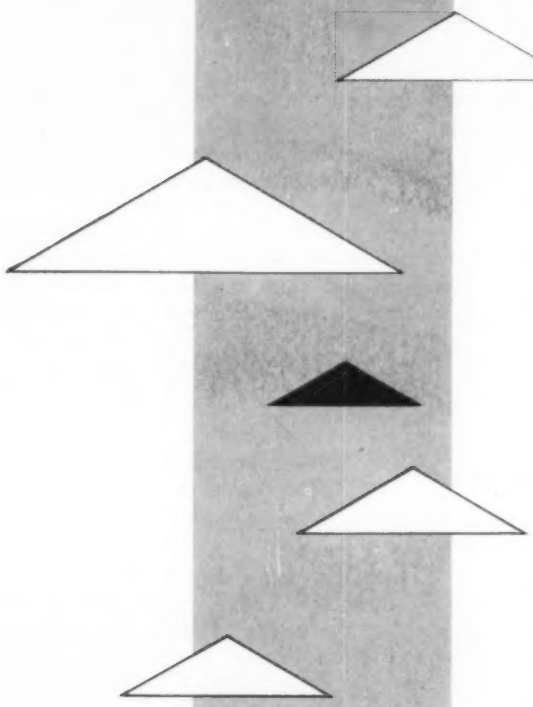
6406 Plymouth Avenue, St. Louis 33, Missouri

WM60-2A

All-Angle Operation

The sleeve bearing design, in fractional hp ratings, has a positive lubrication system that permits operation in any position . . . can mean important savings in motor costs to manufacturers.





PRODUCT ENGINEERING
SPECIAL REPORT

ILLUSTRATIONS BY
WALT TRAG

WHICH WAY UP...

TECHNICAL OR MANAGEMENT?

How can the non-administrative-minded engineer, the specialist and the senior man be recognized? The only classical—and the wrong—road has been through management, but newer and more realistic programs are emerging, which are making effective use of each man's abilities in the proper place. Here 32 high-ranking engineers in as many major companies contribute their ideas. At the same time, they offer sharply contrasting opinions on the status of the engineering professor.

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■ Throughout history, the man who showed superior performance has become the commander of others—for good or bad. Since the Industrial Revolution, when factories emerged, this classical pattern has been followed. **Until recently.**

There have always been tales of disillusionment—the competent technician who became an administrator, willingly or not, and found he didn't like it; the scientist who rebelled against the personnel and paper work; and much more commonly in recent years, the engineer who found that other duties interfered with—or eliminated—his engineering contributions. **There have been many extremely competent men who have been converted into very incompetent managers or submerged in paper work, to their own and the public's dissatisfaction and loss.**

This has been more evident since our products have incorporated astronomically increased technology. The remedies have been many and varied—attempts to teach management techniques—either in plant, at special schools, or in university "crash" courses—provision of management-trained assistants or associates. **But the realization has been growing that these are not the complete answer.** Some men have no talent for or interest in management; forcing them into

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management can only create trouble. The old shop adage still holds: "A good mechanic is usually a bad boss."

Yet our economy clings inexorably to recognition of managerial status as the gage of success. Labor fights to change its collar from blue to white. All grades of management seek more resounding titles and incomes because of social pressures. As several recent books have overemphasized, **we have become the most status-conscious nation in the world.**

What can be done for the "individual contributor" who is extremely important—and likely to be more so—in the operation of the technically oriented company? He is usually conscious of the social pressures at home and outside; usually concerned about America's belief that attainment and success are measured in dollars and titles. Yet titles are traditionally given only to management men, and income tends to rise with title.

Even the college professor in America has been affected. It is, as one engineer says, "indeed a difficult thing for the engineer to accept that he can go as far on his technical merit as he could employing managerial skills. This difficulty arises even though we can give examples of men who have actually followed this course. This leads one to conclude, as you have, that there is inevitably more prestige in a management position in the minds of our people."

Nobody should be more able to answer the questions on this score than engineering vice-presidents and chief engineers. So we asked such men in major companies in the design field to offer their opinions on the "dual-road-up" problem—and more importantly—their solutions. In the paragraphs that follow, we quote from 32 men who are identified on the final page.

FIRST: WHAT TITLE, WHAT SETUP?

Among the more familiar plans for dual-channel advancement is that of General Electric. **This is not a mutually exclusive plan; there is no one point in a man's career at which he must select either the technical or the managerial path upward. Further, the management path does not open the door to higher opportunities than are offered by the more technical path. It is common to shift back and forth, working up through a number of supervisory and individual-contributor positions.**

Actually, there are a number of individual-contributor positions in both operating departments and in the company-wide "services" operation that are filled by men with successful managerial experience who are currently broadening their capabilities.

Also, moving into a managerial position does not necessarily end a man's recognition as a technical expert. As examples at GE: Glen B. Warren, formerly manager of the Turbine Division, widely recognized as a turbine designer. The late W. R. G. Baker, a pioneer in television design and long-time vp & gm of the Electronics Division, and later, by his own choice, an individual consultant. Harold E. Strang, expert in switchgear design, for a long period vp & gm of the Measurements & Industrial Products Division, and who currently, approaching retirement, is vice-president and consulting engineer in the Switchgear & Control Division.

In the GE plan, a number of individual contributors have positions and compensation higher than those of many managers. These positions carry such titles as:

Consultant—Advanced Development
Consulting Engineer
Consulting Engineer—Heat Transfer
Consulting Electrical Engineer
Senior Electrical Engineer
Senior Physicist

Westinghouse has a similar system, with two classifications representing various levels of competence on the strictly technical side: consulting engineer or scientist, as the case may be, and advisory engineer or scientist. Many companies have systems, particularly in R & D, which work more or less well, depending upon size and actual belief in the policy on the part of administration, as will be abundantly apparent in subsequent quotations.

Another factor that may hold hope is for parallel recognition is, as one man says it: ". . . that the fad for educating top people along managerial lines is yielding to the technically trained approach."

Senior staff engineer?

One company instituted, early in 1959, a vertical classification system consisting of four levels. There is no formal equivalence to the supervisory ranks; the top non-supervisory level, senior staff engineer, enjoys status and pay ranging up to that for the second level of engineering supervision. The second level, senior engineer, rates slightly below first-level supervision. The expectation is that first-level supervisors will be selected in approximately equal numbers from the second and third engineering level, with very few coming from the first level.

The company expects to extend upward both compensation and status for non-supervisory engineers, but probably not into executive levels. **In this organization, about half of the engineers with 15 or more years of employment are in supervision, engineering or elsewhere.** This reflects the very heavy engineering content of the products—which are not military. Several other examples:

Central and satellite

"We have over 20 divisions—each of which has an engineering department headed by a chief engineer. We have set up a central R & D department, as well as engineering-management departments—about 80 people working on problems related to those of our plants. A separate research department is, of course, confined to new or future designs. Part of this headquarters staff, however, are engineering managers who work between divisional chief engineers and headquarters management. These headquarters engineers, headed by the vice-president—Engineering, counsel and advise divisional managers and chief engineers on product problems as well as aid with design; and many are engineers who have been advanced from the divisions. These men are considered managers of engineers. They must learn to wear several hats, so to speak, working with management, sales and engineering problems related to the product.

"We do not have people in our organization termed 'consultants' or 'fellows,' who are specialists in one particular technical subject. I suppose it is because we are just not big enough. We have a few 'consultants'—retired engineers retained and called in on certain problems. The only 'fellows' in our company are those who have been honored by ASME, AIEE or AIChE . . . I am sure that the engineer who enters management is nearly always opening the door to greater possibilities than he would have as a technical specialist—because of his wider accountability."

Another structure

"We have tried to make both paths attractive, so that good men could find opportunity and satisfaction in either. One way to formalize this is in the job structure. We have these positions, which compare directly:

Technical	*Management*
Chief Engineer—(Specialty)	Manager of Engrg
Senior Engineer—Project	Sr Engr—Design spvsr
Engineer—Specialist	Design Engr—Group

"Above these jobs we have chief engineer for the company and vice-president of Engrg, R & D. The latter jobs include major management responsibilities and have been filled by those who have come up primarily through the engineering-management side . . . **We have not yet succeeded in establishing recognition of technical specialization comparable to our higher levels of management, but I believe we will trend in this direction** . . . but not to exceed vice-president."

Top job: research scientist

"Approximately four years ago, we initiated a dual ladder of advancement for technical persons . . . The highest position is known as a 'research scientist.' This approach has not been entirely satisfactory. The primary deterrent appears to lie with the technical people themselves, and their concept of what constitutes status in present-day society. **Scientists who agitate hardest for technical recognition are often the most reluctant to accept it . . . We have discovered that the outward trappings such as private offices and private secretaries are extremely important;** and although we have attempted to provide these status symbols, support of the 'dual-ladder' plan has been half-hearted . . . despite the creation of a salary potential for a research scientist commensurate with that of men in top managerial positions.

"**A serious problem accompanying the technical-ladder approach is the difficulty of clearly defining responsibilities and standards of performance for each level.** With no set standards, there is the tendency to promote to the next highest level when the top of a salary band is reached regardless of performance . . . **promotion is too often based on longevity and time in salary grade instead of merit.** If no specific organization plan exists limiting the number of scientists at each salary level, the result is a department top-heavy with high-level, high-salaried personnel."

Staff engineer = dept manager

"We have two approaches for the technical man: the position of staff engineer, which is rated as high in salary as department manager; and an administrative organization to take the routine load away from department managers and project engineers as much as possible, thus allowing them more time for strictly technical work. These are only halfway measures, and the answer will come when some way is found to allow the technical man in industry . . . to progress without limit in salary and prestige."

A complete plan

"We have made limited application of the 'parallel ladder' plan. The highest rated non-supervisory engineering title is 'research engineer.' The salary schedule permits remuneration greater than the average paid to the first level of engineering supervision (engineering section head). We also have an 'engineering section head—research engineer' classification which has salary possibilities equivalent to that of a research engineer. Above this point there is no generally used parallel ladder.

"We also do a number of things to build up the prestige of the engineer as a 'professional' and also to give public recognition to individual technical competence. **These include encouragement of, and assistance to, the engineer in preparation and publication of technical papers. We have two media for publicizing individual tech-**

nical activity, a magazine widely distributed both within and without the company, and an information bulletin for engineering personnel distributed to the homes of all engineers. Publicity is given to the award of patents to our egnineers and financial support is provided for individual membership in technical societies.

"A recent, and more pertinent action, has been the establishment of a technical staff reporting to the vice-president for Engineering. This function is staffed by engineers chosen for their technical competence and who have the title, member of the technical staff.' Salaries compare favorably with those paid to the first two or three levels of management. Additional symbols of status are granted, such as reserved parking, distinctive badge passes authorizing special privileges, and a difference in the treatment of financial progress through merit.

"We presently are involved in inaugurating a new development center. Operations of this nature offer the best opportunity to recognize scientific status. All scientific staff members will have the title, 'research-staff member.' The salary level of an individual within the group will reflect the scientific community's acceptance of him as an authority in his scientific field. Contrary to usual organization-position evaluations, the position to which research-staff members report administratively will not necessarily encompass the duties of the research-staff member, therefore, are not necessarily evaluated as highly.

"These recent steps do not offer the possibility of extension to the great number of senior engineers who have displayed technical competence. It is doubtful that the complete solution to the over-all problem can result entirely from company efforts. Fundamental to the difficulty of creating the desired prestige is the fact that, in the business community, prestige and status are conferred in proportion to the authority that one man has over others and the extent of which he participates in the management functions."

Don't miss the long range

"We place great emphasis on parallel paths... there is general acceptance of the idea that the company tries in every practical way to assure equal recognition. There are imperfections, but we are constantly trying to work these out . . . We find in practice that only a few men can maintain and sharpen their professional abilities when they also take on top-level management responsibility. These few men will, of course, earn more as managers than will a non-manager of equal professional ability . . . Frequently, however, management responsibility over a period of years brings about some dilution of professional ability, and we observe that the dedicated professional will equal or exceed long-range earnings of managers in this classification . . ."

How does "project engineer" sound?

The project engineer is familiar in the aircraft and missile industry for being just what his title indicates. There are no connotations of age, seniority, or salary, these being dependent upon the size of the project. However, some older industries have picked the title to solve the status problem. Here are two examples:

"We have found the title of project engineer to be very adaptable to our company; it rewards the engineer with both status and income commensurate with his abilities. Our project engineers and senior engineers are responsible for individual projects or areas of automotive design. They have little or no management responsibility other than to their immediate superior and the design of components for which they are responsible."

"We permit a good engineer to advance as a leader, design leader, project engineer. If he shows evidence of other interests, we encourage the interest and take advantage of the technical background in other phases of the business (possibly excepting accounting). This is particularly true in any position dealing with the public or the client—engineering management, sales, estimating, purchasing, manufacturing, production, service, research, even company administration—because it is most desirable to have technically trained men in the heavy machinery and machine-tool business."

A German approach

"I personally tried, when I was in charge of the German Rocket Development Center, Peenemuende (17,000 employes) the following way: All division and department managers were qualified engineers or scientists with the exception of the head of the Administrative & Treasury Dept. To keep their engineering ability available for the job we had to do, I attached to every one an experienced technical and administrative assistant, who had to take the everyday work away from him and who was allowed to confer with his boss not more than one hour every day, and only in order to get a fundamental decision. This way the department heads were free for their technical jobs. This method worked fine and I had no problems. As far as I can find out, the NASA Marshall Space Flight Center in Huntsville, Ala, is organized the same way."

A two-year appraisal

Said one engineering vice-president in a speech almost three years ago: "Some modern managements are meeting the problem by creating higher-paying jobs in special non-management areas—posts such as senior scientist or consultant engineer. These may pay more than does the position of head of the laboratory or head of the engineering department." He reports that this

system is currently working well in nearly all cases in his own multi-division company: "The engineers selected for specialization (with their own understanding and approval) have generally been productive, cooperative, and of good morale. Of course, there is the occasional man who is dissatisfied with his position and wants to try the other route. Usually he is the one who we think is not management material, and there is a parting of the ways. Conversely, we occasionally find an engineer who was selected to try the management route but who decides he prefers to return to technical specialization. **This is not regarded or treated as a failure,** and the man becomes a valuable member of the engineering team. As in most personnel matters, **this plan works well when intelligently and carefully administered by competent and interested people.** The administrator can never take the attitude that 'you have made your bed, now lie in it.' Understanding and good communication in both directions are necessary."

Pick leaders for management

Actually, of course, the problem of parallel paths is subordinate to the problem of management itself. **The greatest shortage in the modern corporation is management personnel.** Top management requires a total capability and drive that most men simply do not have; leaders—really good ones—are a very scarce article. The leader should not be picked because he "deserves" the job—through technical capability, seniority, technical or commercial knowledge, or any other past accomplishment or training. He should be picked for one reason only—**his ability to lead.** Because the real leaders are scarce, salary brackets are at the top, but the openings are not limited to any group or class if the company is progressive.

To sum up the prestige discussion . . .

This matter of parallel achievement can be measured in two areas: status or prestige and salary. The status achievement we have seen is difficult to attain, because the public at large recognizes achievement in terms of title and perquisites. "How many men do you supervise?" is a basic question.

Consider one final and almost-ideal case in which an exceptional engineering specialist can *theoretically* achieve a vice-presidency with a salary paralleling that of the vice-president, engineering. *Practically*, it is a difficult pinnacle. In this instance, the director of research approaches this situation; in a few years he may be considered for a vice-presidency. He is *not* a manager, even though he heads a department; management of his department is done by a qualified administrator. He has the title (and salary) of a manager because they give him the status that his achievement deserves, and he does exert a strong technical leadership in many areas.

In one instance, men carrying the title of chief engineer make strictly technical contributions. In others, technical men are titled staff engineer or technical assistant to . . . , or even director or associate director of research. In one case, an "administrative manager" handles managerial duties, in others there are parallel chief engineers, the management man's title reflecting product orientation while the technical man's reflects development orientation: chief engineer-development, and chief engineer-products.

Obviously, such a setup plays havoc with the conventional organization chart. But the chart can be fitted to the men, *if their competence warrants it.* Says one engineer: "Over the years, our most successful product lines are those resulting from the intense personal dedication and leadership of one individual. This man is seldom a manager, but his creative contributions, his drive and perseverance supply the product leadership that brings success."

Decentralization in many companies has been very helpful, because it provides closer contact within the organization between departments, more status and prestige for the individual. It provides more slots, in a manner of speaking. As one engineer puts it: "In the smaller operations, all hands quickly learn to respect the technical contributions of a good engineer and his impact on the success of the products in the marketplace. Outstanding engineers can move into the headquarters staff and have contact with top management and enjoy many of the physical status, symbols: rugs, wood furniture, executive dining room, and the like."

COMPENSATION ISN'T USUALLY EQUAL

In theory, and if the system really worked, the man who takes the technical road can be as well compensated as the one who takes the managerial one. In practice, and because the system usually hasn't worked thus far, this ideal is not reached. One man after another admits it is the "rocky road" I mentioned in my question about it. For example: "It is unfortunately true that the man who commands the greatest financial respect is the one who climbs up through management. The space age and the nuclear age have tended to give recognition to the highly successful technical men . . . but they are not paid accordingly. In companies like ours (older and more staid products—Ed.) the top technical men usually do not even attain their share of recognition. I have made a personal crusade for a number of years . . . but the fact remains that they are never paid as much as the managers of departments."

Or again: "There are of course certain rather-restricted salary benefits which can be applied in place of advancement to management positions and as a reward for proficiency in a given position. Obviously, this means ultimately may be exhausted . . ."

And again: "Salary-wise we have made some progress, and we have done reasonably well by a few scientists and engineers who fall into this category. But there is still a strong tendency toward 'compensation in line with the size and importance of the group supervised' and an attitude of 'we cannot pay him more than the guy running the whole show.' I am not sure that we shall ever find the answer to properly compensating the specialist in relation to the manager. Before we do, it will be necessary to develop a good yardstick for measuring relative worth. This has not yet been done."

Some dismiss the compensation problem quite simply: "A great many men are not qualified for administration, and others haven't the slightest interest in it, but both kinds are very necessary. True, those without management ambitions are limited financially, but this has presented no problems. The management jobs pay better and carry more prestige, therefore they are the jobs most sought as a general rule. They are the extra incentive for the ambitious. Mr. ..... our vice-president and general manager, ... Division, is a graduate engineer who worked on the board at one time."

Or, somewhat more bluntly: "We have a technical path, but it is very short. Few engineers stay on it . . . Engineers who do so become highly specialized in their line of work and cannot communicate with management. They concentrate their effort on pursuing academic ideas without regard to profit, which is the life and blood of the company. Thus they become a troublesome problem to management. Engineers who are engaged in product design invariably are headed for management jobs because to make a product profitably saleable, one must accomplish a management function to a degree . . . In short, in our business, I have very little use for an engineer who does not have the ability to manage, who does not understand the problems of management, and who does not contribute to the management goal; namely, making money for the company."

The problem of recognition, and some solutions

One company offers six-part recognition for the specialist:

1. Salary scales equal to those of equivalent management echelons.
2. Titles (senior development engineer, senior research engineer, consultant) given to men who have proved their qualifications.
3. Facilities (private offices, etc) and services equal to that for supervision.
4. Individual credit lines and reference in reports to top management on research activities and product developments. In the latter case, such references are tied to market positions and profits realized.
5. A *minimum* of supervision—establishing an "easy but competent" way of operating that is the envy of some supervisors.
6. A deliberate program to keep the specialist in personal contact with and known to other company departments and import customers in his market work areas.

Another executive says he uses all of the "usual instrumentalities," including "occasional special tangible awards, special assignments here and abroad, awards for invention productivity, public recognition at company luncheons or dinners, etc."

Says another: "In the 1950's we set up a parallel plan for advancement of engineers and scientists who wished to stay strictly in the technical field . . . This plan consists of a number of classifications and titles starting at the lower level with staff scientists and staff engineers and continuing on: advanced system engineers (scientists), senior R & D engineers (scientists), with the highest classification called consulting engineer (scientist). (This title may be contrary to licensing laws in some states—Ed.) Beyond this, the opportunity lies in chief scientist of a division or subsidiary. Our experience with this system over-all has been very good; no major problems have shown themselves and we are continuing the practice."

Europe does it better

"There may not appear to be much of a status problem on the surface, but underneath there is . . . take it from one who has been on both sides. I dislike the GE and Westinghouse terminology, but have been very much impressed with that used in Europe. There many senior engineers are called 'doctor engineers,' and the prefix of 'engineer' to a man's name also has distinct status. Perhaps the European practice is much to be preferred to the American concept of differentiating between the vocations of management and of the technical sciences."

The man himself may complicate

"Status-wise, we have a more difficult problem and one in which the engineer or scientist himself plays an important role. Within the confines of his own company, particularly with respect to other technical people, his ability alone provides him with adequate status . . . To some degree, this prestige also exists in the eyes of non-technical people in the organization. To a much lesser degree, it carries over into the community. We have used techniques such as news releases on technical accomplishments to help build community prestige for the man; however,

much more could be accomplished if the man himself were more disposed to advertise his own existence. In most cases, the nature of the technical specialist is such that he doesn't make himself felt in the community through civic, political or social activities, and as a result, the manager who does such things attains much greater visibility and social status."

It's better to report high up

Where should a senior engineer report? Apparently, it should be at top levels, or the prestige of bearers of the title suffers. Says one respondent: "We use the title of senior engineer for those who follow the path of technical specialization. The salary range has no ceiling. Senior engineers report directly to the director of engineering. Requirements for technical know-how and engineering background are extremely high, so that there are only two senior engineers in a divisional engineering department of more than 100 men. Although the organization chart would show the senior engineers as staff assistants to the director of engineering, they are assigned technical responsibilities . . . (by him) that amount in fact to administrative control over the technical aspects of the project. The assistant chief engineers, the product engineers, and, in fact, the director of engineering himself, all recognize that these men have superior technical abilities, and they are accorded proper respect: It is common practice for beginners to address the senior engineers as 'Mister,' just as they would the management people."

In other instances, senior engineers—or their equivalent, because many executives seek a better title—do not report at so high a level and do not exert the same technical authority. They therefore do not receive the same recognition and the setup does not work out as well. Says one engineer, bluntly: "I believe that the reporting level has everything to do with the success of this organizational structure. It is important also that all levels of engineering management recognize the fact that the senior engineers may receive higher salaries than they do. The practice of bestowing the title of senior engineer merely in order to justify a salary increase cannot be condoned."

It is important, however, that the word "engineer" be included in the title (unless state laws prevent it), because the man himself feels it is very important in many instances. It provides prestige and establishes position.

THE PROBLEM IS IN THE MIDDLE ZONE OF AGE AND INCOME

1. "In my opinion, it is not the exceptional man we have to be concerned about, but the large middle group of engineers who have to decide, after they are in industry five to seven years, whether they will get ahead further and faster as technical contributors or as managers. In salary and prestige, this group will do better in management, other things being equal. The achievements of the technical man in this group may be excellent, but only infrequently outstanding enough to attract the attention and earn the respect of top management and the rest of the organization. The increasing degree of specialization required may so compartmentalize the man that only a few people in the company can understand what he is doing, or judge the value of his achievements. His equivalent in management is much more frequently seen by top management as part of the daily routine . . . and has direct personal impact on all of his subordinates in a way they understand."

2. "Somewhere below the apex (in company management) there is a two-path situation: the 'do-it-yourself' and the 'do-it-through-others.' These should be parallel, and will be if certain things are done."

3. "We have had some problems in finding titles for engineers and research people when they reach a point at which their salary conflicts or must be advanced beyond that of others with the same title. For instance, we might have the titles of junior engineer, engineer and senior engineer in order. One or two titles above senior engineer would be handy for salary brackets. Now we use the term 'manager' in this bracket, but this implies management, and in fact such a man usually has a number of people under his supervision, even though he may be a specialist in one of our lines."

Don't forget union limitations

Only one interview brought up the problem of unionization. He also distinguished between management as such and administrative tasks, which I had roughly lumped together as taking engineering time. "It seems that you are talking about people who are line and operating managers rather than staff people. Because of our situation with the union, we have a very clear-cut labor-management definition and so cannot differentiate between management and 'technical specialists.' Similarly, because we are unionized, we do not offer status symbols in lieu of money. We do, however, recognize technical competence within our management structure and do have management people in staff positions with only nominal administrative or 'management' responsibilities . . . We do this because the technical competence of these people is so high that we do not want to dilute it by burdening them with 'administrative' tasks, which you seem to imply is management. The procedure we are following works out very well . . . One other observation I might make for what it is

worth: In general, people are only interested in stature when they are not hungry . . ."

An interesting—and the ultimate—facet of the problem: "If my memory is correct, Steinmetz was not considered a management person at General Electric, nor was Einstein engaged in administrative activities at the Institute for Advanced Studies. It is too bad that we have to recognize the genius before we establish the position. Perhaps in the future, such positions will be established for potential geniuses, many of whom must exist today in an environment that does not properly cultivate their abilities."

The difficulty, of course, is to identify the genius—which none of our present tests can do with surety. And there is increasing evidence that part of the achievement of the genius is to overcome resistance; if things are made easy for him, he is not extended to his utmost. For a breakthrough, there must be something to break (*PE*—Aug 24 '59, *p* 20). And the productive period of a genius is likely to be short.

HOW DO COLLEGE PROFESSORS "RATE" IN THE PUBLIC MIND?

Any question concerning an engineer's immediate relationships is certain to draw somewhat subjective replies–it hits too close to home. However, a similar question concerning a parallel field or situation can often clarify the opinions because an engineer's answer can be truly objective. Actually, my second question had this effect, although the original intention was simply to sample current opinion on what seemed to me an associated condition–the current opinion of the engineering professor. I suggested that the college professor had been losing status in recent years, at least in comparison with his fellows in Europe, and asked why this had occurred. Is it income–or something else? How important is income in relative status?

Eight respondents either had no opinion or did not answer the question. Of the 24 who did answer, 11 agreed with me while 13 disagreed, although in the latter group were several who felt that the situation had changed radically since Sputnik I. **(It appears that the date of October 4, 1957, will go down in history both for a scientific achievement and as a turning point in public opinion of the technical educator, scientist and engineer. It is seemingly the date upon which the average American was shocked into the realization that he is in the grip of an unparalleled technological advance and a deadly international competition that we must battle to win.)**

"The educator IS losing status"

Of the 11 engineering executives who agreed with my expressed opinion, several felt that income is a major factor. Says one: "Status is very definitely tied in to the material manifestations of wealth or simply amount of personal income." Another feels that loss of status is "partially but very significantly related" to income and observes: "The secondary effect of this, which tends to drive some of the better men away, is, of course, very deplorable for the long pull."

Neither he nor anyone else mentions the cry of college administrators that industry lures good educators away with money. One, however, points out that "the professor has been losing status for a much longer period of time than that during which there has been a drive to get increases in salaries . . . the better colleges and universities certainly are fully competitive with industry in the salary levels which they offer." Our own survey of Design Town (Dec 26 '60) included one man who had suffered a financial loss by returning to industry from the campus—partly consulting fees.

A positive approach: "Highly paid administrative people tend to look down on those who are willing to work for the incomes which have become standard for college professors. The answer is for all of us to help do something about getting the remuneration of college professors up to the level where it belongs. I have been active on a committee at the State University for that purpose, and we have accomplished some things, but not a great deal thus far."

An added reason that applies to engineers and creative men as well: "Salary is a large part of this (loss of status), but in addition, he (the professor) suffers from lack of a good public image. He is often pictured as absent-minded, carelessly dressed, having eccentric mannerisms, unable to explain things clearly or to come to the point. These problems are difficult to solve. The engineering schools that have close association with industry usually can achieve a better climate for their professors. While money is important, the public at large must in addition be taught to respect mental and moral achievement."

Another opinion: "Should we not consider that with the tremendous increase in college attendance, with equivalent increase in instructors . . . quality has suffered. A college professor used to be a "rare bird" and a member of a small but closely knit group–highly regarded. Now we have a few remaining, but we also have many part-time instructors–graduate assistants, etc–who do not carry the "sage" image one used to associate with professional position."

A critical trio

Three men are rather blunt in their criticisms. One points out that professors' "opinions are given more credence than they deserve." Says he: "I have been greatly disturbed, any number of

times, by what I believe is a serious failing on the part of many educators to grasp the implications of American industry. I think there is an absence of practical idealism in education. For instance, many teachers of industrial design and allied subjects are critical of the American automotive industry and the compromises it makes. They fail to make a distinction between the fine arts and commercial art—and I use the latter term with no apology.

". . . If our products cannot be sold, we can find little consolation in the knowledge that, at any rate, they are artistically excellent. Because so many educators fail to realize this, their students find themselves entering a business world with whose practical problems and considerations they are unable to cope. . .

"Unfortunately, those in a position to elevate the status of the professor by financial means—the college administrators—too often are unable to do so. . . Organizations such as the Ford Foundation recognize this problem . . ."

Here's another suggested reason that ties in with the first question (about engineers in management): "The loss of their prestige is a result of the fact that most of them entirely ignore emphasis on management capability of engineers. They mislead kids into believing that all they have to have to succeed is technical knowledge. If they would be practical and teach, in addition to technical subjects, how to plan, motivate and control engineering projects, my life would be a hell of a lot more pleasant."

The third: "I expect that some loss of professional recognition has resulted from the fact that more scientific work is done by our government and by industry, and relatively less by universities, who once represented the primary source of scientific research. In this respect, I think we can be encouraged by changes taking place in several engineering schools which will assure that the faculty does play a part in current technological advances. I understand that at MIT, for instance, the engineering faculty is required to take an active part in R & D work and encouraged to become associated with some of the many government and industrial projects being carried out on the campus. Other schools are gearing up to expand the work they do for, or in cooperation with, industry. I would expect this to be a boom to the college faculty from the standpoint of income as well as professional recognition. Certainly the continuous exposure to new and important problems, and the recognition given for solving these problems, is stimulating to the teacher, just as it is to the full-time engineer."

"THIS COUNTRY IS RUN BY COLLEGE PROFESSORS"

This remark, once said facetiously, contains a great deal of truth. While it applies to economics and law professors particularly, it has its engineering equivalents in the professors with research contracts, consulting and advisory jobs in industry, who do book and article writing, and are connected with politics. Some of these combinations result in higher aggregate incomes than would be paid by industry.

Several engineers made this point in rebutting my suggestion that professors had lost status. They also point out that if industry hires the competent professor, it kills the goose that lays the golden eggs—the young engineers that industry needs in increasing quantity. And they remind me that many academicians, like many engineers, don't like the "administrative rat race" and the higher pressures and more restricted social atmospheres that go with it. The reasons given to support improvement in status, however, are much less varied than those given to support decline.

"With President Kennedy in the White House, professors couldn't gain stature any faster than they have done recently," says one respondent. "If they are competent, they are gaining in stature, not losing it, and by the way, are becoming very rich at it." Says another, in the same vein: "The college professor has improved his status and income by doing consulting work for industry or by having part-time interest or even ownership in industrial firms.

"With more professors entering industry and the financial-remuneration policies of educational institutions becoming more competitive, status seems to have risen. Not just from the standpoint of a technical organization, but in the community as a whole, visiting professors seem to be regarded on a consultant or highly authoritative level. This may be a result, in large part, of the attendant publicity stressing authorship of books or articles, or in part to the increase in college graduates and students in the community who have had valuable associations with, or high regard for, their professors. In this respect, the college professor probably has more status off campus than he has in the college community."

"I agree that the social status of the university professor is higher in Europe than it is here; however, I believe the standing . . . is improving . . . They rate very high with us." This sentiment, expressed in various ways, is typical of the feeling of men responsible for research activities in their companies; they mention particularly professors from the better-known universities, notably MIT and Harvard. **One or two mention that their own engineers do part-time teaching in nearby universities and get great satisfaction as well as social status from this,** as well as making a significant contribution both in technology and in increasing understanding between education and industry. **A corollary benefit to the com-**

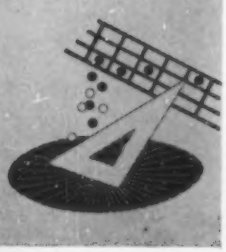
pany concerned is increased prestige for its own research labs.

Again and again, respondents speak of the improvement in public attitude toward science and engineering "in the past two or three years." This is of course particularly noticeable in "industries where we rely on scientific advancement for our product development." To give credit where it is due, several directly mention Sputnik I—**perhaps the greatest favor done us by the USSR because it woke us to our basic danger, as well as to the heavy future responsibilities resting upon educators.** "Since then," says one, "the trend has been abruptly reversed, and the college professor or anyone with a doctorate or lower advanced degree has gained considerable glamor in the eyes of American business management. This is in great part because security analysts in New York keep asking, 'How many PhD's do you have on your payroll?' "

Down with status

Two men mince no words about status, one echoing a statement made to me by a Russian engineer that he knew many ordinary engineers who were much more interesting as friends than men with doctorates. Here is the first: "I feel that the whole subject of social status is somewhat ridiculous, particularly with reference to income. Personally, I know a lot more golf professionals, newspaper reporters and salesmen that I care to associate with than company presidents, even though there is a wide income difference." A Swiss engineer, in this country years ago to negotiate a licensing arrangement, confessed to me that his salary at that moment was higher than that of the company president. The engineer needed the income to establish position and associate with the Americans with whom he was dealing, while the president got his status from his knowledge and he associated socially with a professor, a butcher and a lawyer.

The other opinion: ". . . most people unhappy about status assume it is a gift from outside rather than something earned. To me 'status' begins with our peers. Until they judge us well we have no foothold on that intangible, and they will only judge us well when we deserve it. None of us can be all things to all men, even when we do well in our chosen profession. So when a professor (or an engineer or a scientist) asks why 'someone' hasn't given him social status, does he have in mind a law lobbied through political action (like a minimum wage) or a membership in some social club where he knows no other member, or some artificial title like a Kentucky colonelcy? Sydney Smith said, 'Whatever you are by nature, keep to it; never desert your own line of talent. Be what nature intended you for, and you will succeed; be anything else and you will be ten thousand times worse than nothing.' "



In summation, we quote . . .

To sum it all up, we can quote again: "I don't have any particular solution to offer to the problem, either of the professor or of the engineer. I suspect, as you do, that in some measure at least, probably in a substantial way, the solution to the problem of one will provide the solution to the problem of the other. I think what we need here is something that will change the thinking of the lay public with respect to professors and engineers, and I'm sure I don't know what it is. I am equally sure, however, that there are many engineers who could receive substantial recognition for their technical contributions who are, nevertheless, unable to contribute in an equally substantial way in management positions, so to give them major management responsibilities is a mistake."

ACKNOWLEDGMENT

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The Cooper-Bessemer Corporation—*R L Boyer, vice-president and director of Engrg*
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General Motors Corporation—*George A Jacoby*
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International Business Machines Corp—*T J Weppner, director, Research & Engrg*
Joy Mfg Co—*John D Russell, vice-president—Engineering*
Lockheed Aircraft Corporation—*B C Monesmith, vice-president—Mfg; Hall Hibbard, senior vice-president—Engrg*
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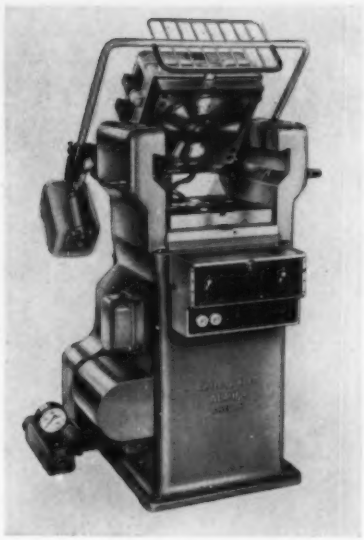
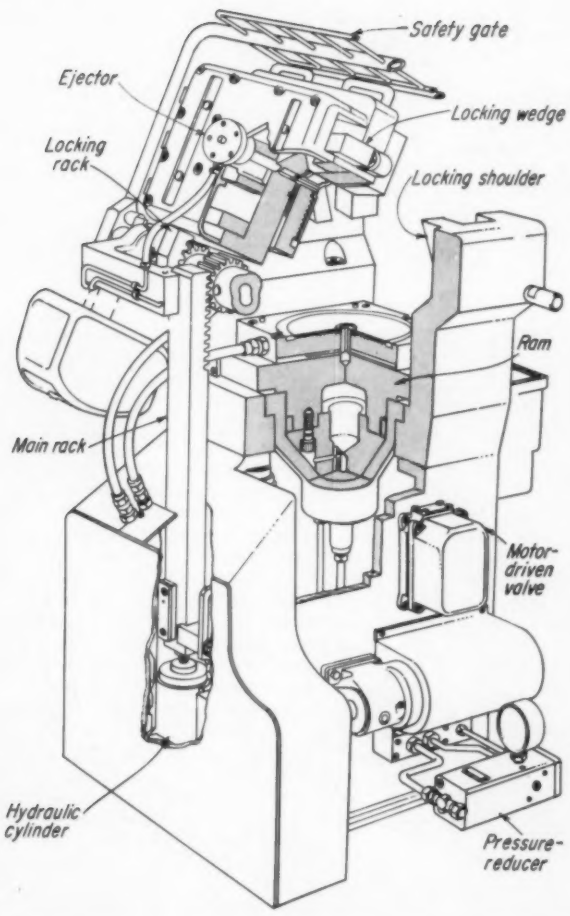
Westinghouse Electric Corporation—*J A Hutcheson, vice-president*
Whirlpool Corporation—*Wm E Mahaffey, vice-president*
Worthington Corporation—*George F Habach, vice-president—Administration*
Zenith Radio Corporation—*J E Brown, vice-president, Engrg*



Record press cooks perfect vinyl biscuit with steam

Battery of timers measures out steam and water in an automatic cycle which assures faithful reproduction of complicated stereo grooves.

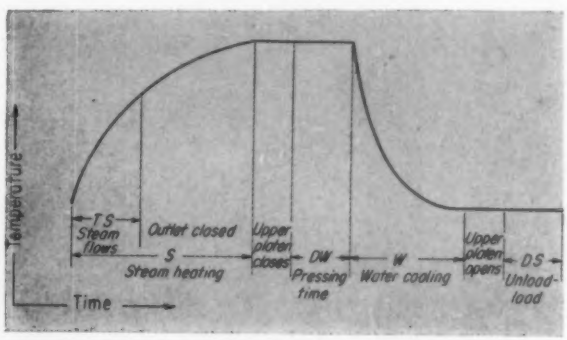


HYDRAULIC pistons close and lock upper platen and squeeze a vinyl "biscuit" into a phonograph record.

First step in automatic cycle is lowering of counter-weighted safety gate by a pneumatic cylinder. Hydraulic piston underneath main rack then goes into action. It pushes up main rack which rotates upper platen closed. As the main rack continues to push upward racks at either side of upper platen swing the locking wedges under shoulders in the frame.

Everything is now ready for the actual pressing. With a short 0.8-in. stroke the ram puts a 100-ton squeeze on the biscuit (3000-psi oil pressure). Less force may be needed for 7 or 10-in. records or for different plastics, in which case an adjustment is made to the pressure-reducing valve which supplies oil to the ram. Instead of a spring adjustment, valve has an air bubble which the operator pumps up or bleeds down.

After the ram lowers and the upper platen swings up to a 45-deg angle, an air-driven center rod in the top pops finished record into operator's hands.



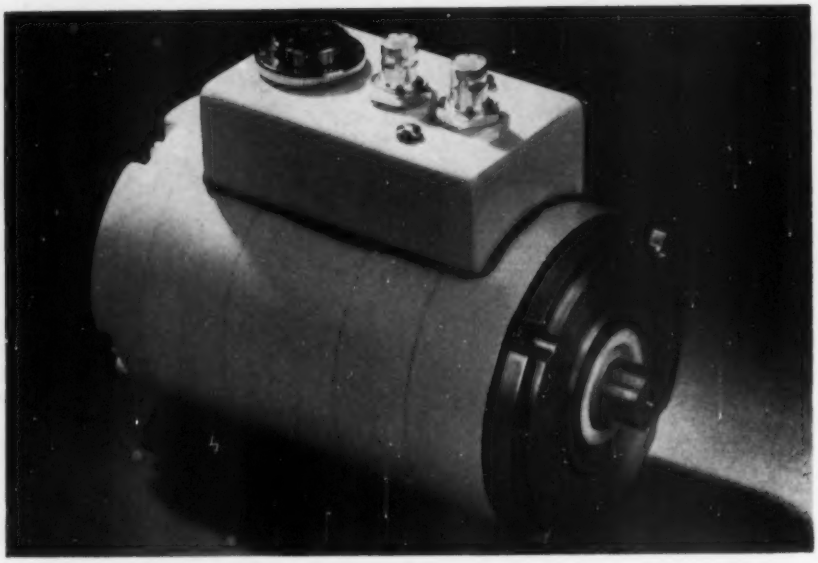
TEMPERATURE CONTROL ensures near-perfect register necessary for stereo records. Five timers space heating, cooling and holding periods beginning with simultaneous start of S and TS intervals.

Length of S period sets mold temperature. When it is over only enough steam is admitted to hold mold temperature constant.

Later, after the record has been formed, cooling water replaces the steam to harden the plastic. One motor-driven valve handles both steam and water.

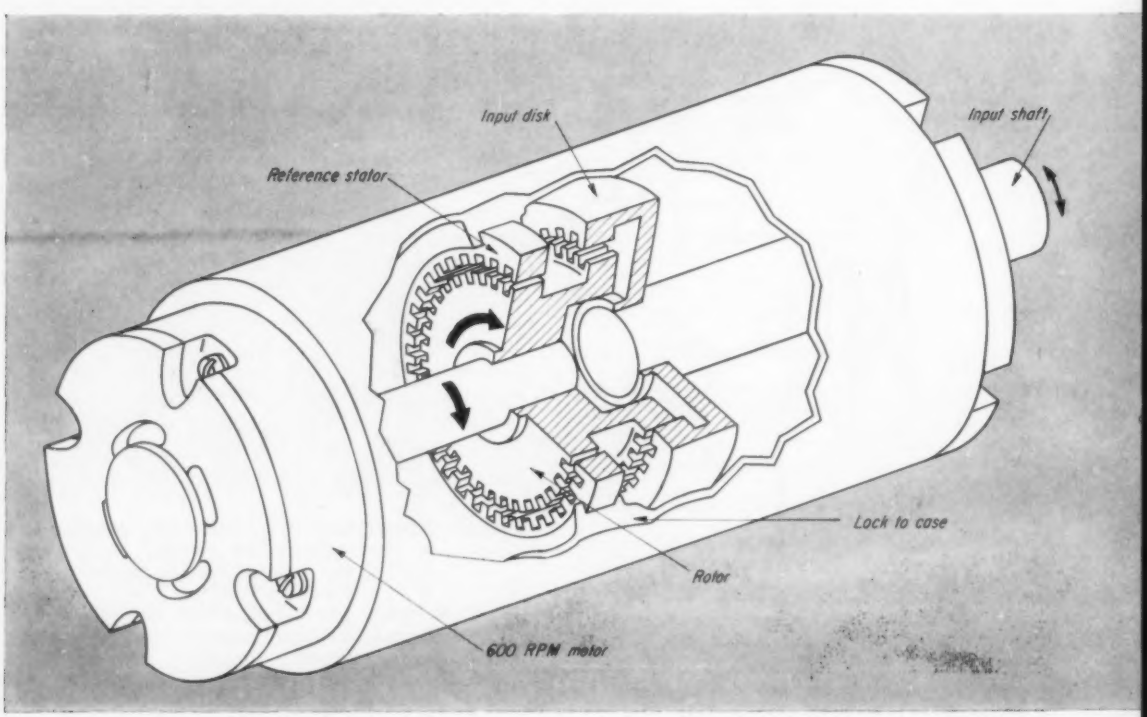
Fastest cycle time is about 15 sec; highest quality records take up to 30 sec.

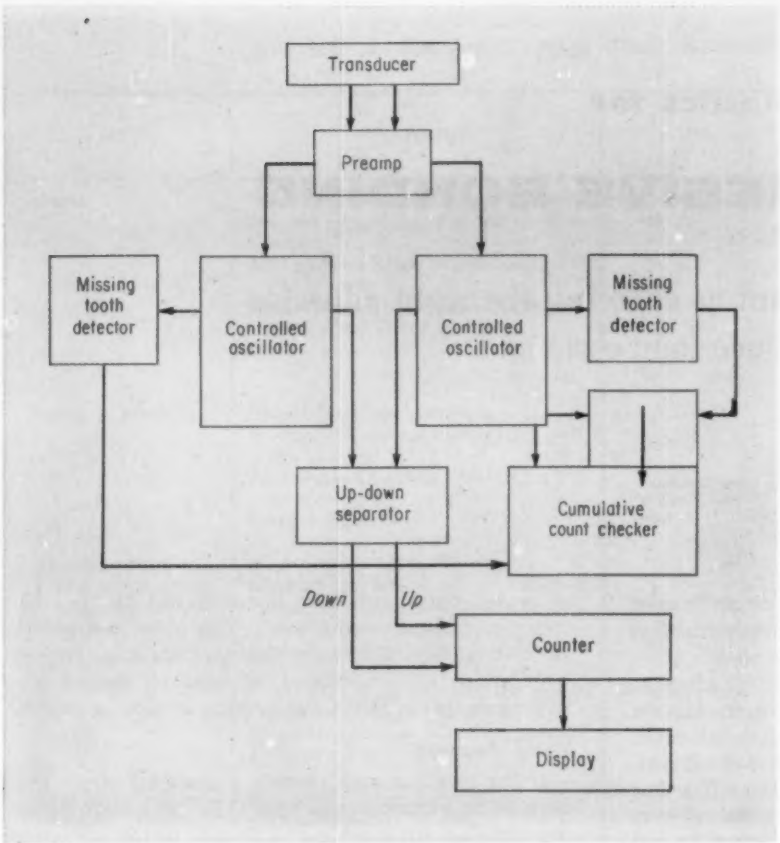
PS . . . Record press changes from automatic to semiautomatic by single toggle switch. Only difference is that operator drops safety gate by hand to start cycle in semiautomatic. Plant must supply 2500-to 3000 psi hydraulic oil, 70 to 115 psi air, cooling water, steam and 220/380-v, 3-phase, 50-cps (or choice) electricity. Manufacturer is Aktiebolaget Alpha, Sundbyberg, Sweden.



Measures angles by ear

Goniometer compares two tones generated by the transducer. When input turns clockwise, whistle is higher; when it turns counterclockwise, whistle is lower. Perfect pitch of electronic ear tells angle within ±2.48 seconds.





ELECTRONIC VERNIER turns transducer output into a reading. Each of the two capacitors controls the frequency of an oscillator which generates a little over 1000 cycles for every cycle of transducer output. Separator and counter tote up the difference in total cycles put out by the two oscillators and flash the result in binary code.

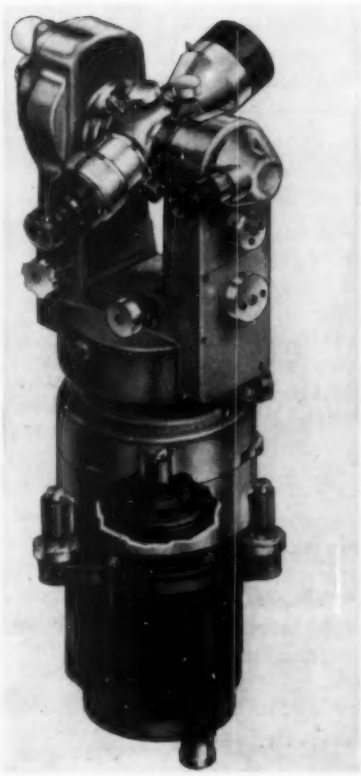
In order to keep the cumulative count from building up errors it is checked against a reference point once per rotor turn. Each row of teeth is missing one tooth. Pulses resulting from alignment of two toothless spaces precisely locate position of the input shaft. If the count is wrong for this location, it is changed, and starts out accurate once again.

TRANSDUCER senses angular movement, sends a signal to electronic vernier which figures out the meaning and prints or displays the result.

The four sets of teeth make up two varying capacitors, one between the rotor and the reference stator and the other between the rotor and the input disk. As the rotor turns and the teeth become misaligned, capacitance changes, eventually returning to its initial value when the rotor has turned one tooth pitch. Since the rotor turns a constant 600 rpm, the rotor-stator combination generates a 5.12 kc signal (600 rpm x 512 teeth/60 sec/min).

If the input shaft were fixed, the rotor-input disk combination would put out the same 5.12 kc. However, if the input shaft rotates opposite to the rotor, the output signal will be a higher frequency, and if it turns in the same direction as the rotor, the output signal will be a lower frequency. Whichever the case, this frequency and the constant reference frequency go to the analytical section for comparison.

The above process would work just as well if one toothed piece in each capacitor had only one tooth. Yet all sets have 512 teeth. Why? The answer is that with only a 2 in. dia a single tooth is liable to be unacceptably imperfect, but errors average out when 512 teeth are used at once.



AZIMUTH THEODOLITE has optics for sighting and a transducer for measuring angle. Original purpose of goniometer was in large rocket-tracking and photographing instruments but it has also been built into precision machine tool rotary tables. Other possible applications include astronomical telescopes, gyro-rate test stands.

PS . . . Microgoniometers range in accuracy from ±0.62 to ±13 sec, depending on number of teeth and speed of rotor. Any model is available for either 60 or 400 cps power supply. With varied electronics, angular readings emerge in any one of several decimal or binary forms—or are converted to rates. Model 512/219 transducer described in text measures 5.30 x 3.375 in., weighs 4.5 lb. Norden Div, United Aircraft Co, Milford, Conn, produces the Microgon system which they developed along with the Colorado Research Corp, Denver, under sponsorship of Ballistics Research Laboratories.

preclean metals and plastics for

ADHESIVE BONDING

It's as important as choosing the right adhesive—and it may reduce joint costs as well.

J N KEMPF*
Consultant, Adhesives, Coatings and Sealants
San Pedro, California

■ Reliable adhesive joints depend on surface precleaning for proper wetting and bonding. The contaminants need not be visible to the eye—a layer of foreign matter a few molecules thick is sufficient to prevent optimum adhesion.

Scouring the part with coarse sandpaper to increase effective bond area won't work with modern adhesives. A surface that is too rough requires thick layers of adhesive. This wastes expensive adhesive and can weaken rather than strengthen the bond. Further, the coarse surface is more difficult to wet completely.

To do its job well, the cleaning cycle must perform two functions:

- Remove foreign matter that impedes wetting of the base material—usual types that must be removed are: organic greases and oils, scale, rust, tarnish and other oxides.
- Influence the surface-tension equilibrium of the adhesive to favor "wetting" or spreading—cleaning should decrease the contact angle between adhesive and base-metal surface.

To make an economical adhesive joint, the cleaning methods must meet several other practical requirements: Solutions must be safe to handle and should not be flammable or toxic. Cleaners must react quickly. This is essential in any high-speed automated setup so that a maximum number of parts can be treated in a given time. Also, the solutions must rinse off with water and leave no residue.

Economics of bonding

Although proper cleaning costs more than superficial cleaning, the higher cost is offset by better reliability in parts and less rework. Proper cleaning may also allow switching to a cheaper adhesive or using less adhesive. For example, epoxy resins have excellent wetting properties, but, they are not as economical where cheaper adhesives and proper precleaning will do the same job.

It is not enough to choose the adhesive on the basis of compatibility with base materials and by the shear strength produced in the bond. You must spell out the precleaning steps and ensure that they are done properly. Then avoid recontamination by handling treated parts with clean cotton gloves and bonding as soon as possible.

Metal cleaning

If the part has scale, specify a descaling step. Then degrease to remove organic soils. The method of degreasing or the solvent is not critical because metals will require further cleaning to remove oxide and tarnish.

The usual cleaning solutions used are acids or bases that attack the oxides more than the base metal. Active acids (without inhibitors), are preferred, even though they will etch metals somewhat, because inhibited acids leave smut films that cannot be rinsed off. (The inhibited acids however are useful for removing heavy scales when salt bath descaling or abrasive blasting is not suitable.)

After the thicker oxide films are removed by pickling, the metal is further cleaned in milder solutions that contain dilute concentrations of acid plus chromate additives. These leave thin films which retard oxidation or rusting after cleaning and promote wetting by adhesives. Alkaline cleaners are not used in the final cleaning because the surfaces they leave are not compatible with most adhesives.

Many proprietary metal cleaners have been developed by companies that specialize in this field. These cleaners usually contain mixtures of acid with special buffers to control over-etching. Some can be used for more than one metal. These cleaners are easy to control and depletion rates have been worked out—baths are discarded after a given amount of metal has been treated.

Thorough washing and agitation in any of the specified baths is essential. Rinsing is just as important. Baths must be kept clean and discarded before the amount of dissolved or suspended soils builds up to recontaminate the part.

Time between cleaning and bonding is critical for copper and brass—they should be bonded immediately. Most materials can be bonded as long as 4 to 8 hours after cleaning.

Aluminum and magnesium present their own special

* Formerly, Manager, Adhesives, Coatings and Sealants Div, American Latex Products Corp

HOW TO CLEAN METALS FOR ADHESIVE BONDING

METAL	TREATMENT
Steels	**Degrease**—Chlorothene, or naphtha **Descale**—sandblast, dustblast or wire-brush **Acid pickle**—20 min in 4% H_2SO_4, 4% HCl in water **Acid etch**—15 min in 12% HNO_3, 2% HF in water (18 to 20 Be) **Rinse**—water; dry
Stainless Steels	**Degrease**—trichloroethylene **Acid pickle**—20 min in 4% H_2SO_4, 4% HCl in water **Acid etch**—15 min in 12% HNO_3, 2% HF in water **Rinse**—water; dry
Aluminum and its alloys (for critical joints and military applications)	**Degrease**—3 min in toluene **Alkaline wash**—10 min at 180 F, in water solution with 4 to 5 oz per gal Turco Aviation cleaner **Acid dichromate etch**—3 to 5 min at 150–160 F in water solution with 20% (by wt) H_2SO_4, 10% (by wt) sodium dichromate ($Na_2Cr_2O_7$-$2H_2O$) **Rinse**—clean water 3 to 5 min at 120 F **Air dry**—at 80 to 150 F
Aluminum and its alloys (alternate commercial treatment)	**Degrease**—vapor degrease or soak in Chlorothene for 10 min. **Acid etch**—5 to 10 min at 155 F in water solution with 6 oz per gal of Sprex "AN" cleaner **Rinse**—clean water **Air dry**—at 80 to 150 F
Magnesium and its alloys	**Degrease**—10 min in trichloroethylene **Clean**—10 min at 160 to 190 F in water solution with 3 oz/gal sodium metasilicate, 1.5 oz/gal tetrasodium pyrophosphate, 1.5 oz/gal Nacconol NR (nonrefined sodium alkyl aryl sulfonate) **Rinse**—in water at 160 to 190 F **Rinse**—in distilled water at 160 to 190 F **Chromic acid pickle**—10 min at 150 F in 20% chromium trioxide CrO_3 **Air dry**—5 to 10 min at 80–90 F
Titanium and its alloys	**Degrease**—10 min in trichloroethylene **Acid chromate etch**—15 min at 120 F in bath of 35 ml water solution saturated with sodium dichromate to 1 liter of H_2SO_4 **Rinse**—in water 150 to 160 F **Rinse**—in distilled water 150 to 160 F **Air dry**—5 to 10 min at 80–90 F
Copper, brass and copper alloys	**Degrease**—10 min in trichloroethylene **Acid chloride pickle**—15 ml FeCl (42% solution), 30 ml concentrated HNO_3 in 200 ml water **Rinse**—distilled water **Air dry**—at room temperature
Zinc and fresh galvanized metal	**Degrease**—vapor or solvent degrease **Acid neutralize**—wash with 5% acetic acid in water **Rinse**—clean water **Acid chromate pickle**—3–6 min. at 100 F in solution with 20% H_2SO_4 and 10% sodium dichromate. **Rinse**—clean water, dry

HOW TO CLEAN PLASTICS FOR ADHESIVE BONDING

MATERIAL	TREATMENT
Cured polyester	**Remove gloss**—sand or light dustblast **Degrease**—wipe with methyl ethyl ketone or ethylene dichloride **Dry**—thoroughly in clean air
Linear polyethylene	**Remove gloss**—flame treat for 3 to 5 sec until surface has dull mat appearance or **Oxidize**—3 to 5 sec in chromic acid at 160 F or **Electric-arc clean for local bonding**—by discharge of a Tesla coil unit
Medium density polyethylene	**Remove gloss**—flame treat and sand
Rigid or flexible vinyl	**Remove gloss**—rub with abrasive powder such as Babo or Ajax **Clean**—with ethyl alcohol **Dry**—thoroughly in clean air
Natural rubber	**Degrease**—wipe with toluene or naphtha or **"Cyclize"**—wipe on or immerse in concentrated H_2SO_4 allow to oxidize surface for 5–10 min at room temperature **Wash**—in clean water **Flex surface**—mechanically work surface to open hairline cracks **Clean**—solvent wipe with n-butyl alcohol
Synthetic rubber	Cleaning varies with the material but these steps will generally work: **Degrease**—solvent wipe with naphtha or toluene **Clean**—wipe with ethyl alcohol **Remove gloss**—scrub with abrasive powder **Rinse**—water **Clean**—with ethyl alcohol

problem—they react with hot water and must not be kept in rinse baths beyond the specified times. Aluminum should be coated with the adhesive within 3 hr of cleaning and preferably within ½ hr. This prevents further oxidation and increases joint strength by improving the reaction between the metal oxide and adhesives.

Cleaning steps for plastics

Most molded plastic parts are coated with release agents or mold parting compounds. These must be completely removed for bonding. Plastic parts generally wet more easily when the sheen or gloss is removed from the surface. Mat surfaces wet more easily not because of their rougher surfaces, but because of freedom from contamination. So gloss-removal steps generally use fine abrasives such as fine sandpaper, a fine vapor blast or dust-blasting followed by clean-air blast to remove the dust.

Thermoplastics may be degreased with mild solvents such as hexane or alcohols. Trichloroethylene or other chlorinated solvents attack most thermoplastics. This permanently weakens the surface because of crazing. Aromatics and ketones can be used on thermoset plastic surfaces.

Natural rubber, particularly hard vulcanized rubber, should be "cyclized" with sulfuric acid to create fine surface fissures for adhesion.

Polyethylene, itself a parting agent for adhesives, is difficult to wet. In abrading the surface to remove surface gloss, direction of sanding should be perpendicular to the loads on the joint. This provides some mechanical interlocking to aid joint strength.

Most difficult to handle are the fiber-reinforced plastics because the joints carry high structural loads and must be reliable. The thermosetting resins usually used do not have good ductility to distribute the load. In addition, the reinforcing fibers act as wicks for oil and water. Once they are contaminated, they are almost impossible to clean completely. Resilient or semiflexible epoxy adhesives have generally been found most suitable for bonding reinforced plastic components.

A test for wetness

Here is a simple test to determine whether parts are clean enough to be wetted by adhesives. Place a drop of distilled water on the surface. If the water wets the surface and spreads into a film, the surface is reasonably clean. If the water forms a ball on the surface, it is not clean enough to give a strong joint. Similarly, adhesives themselves provide a good production check. If the part is contaminated, adhesives will pull away from the dirty area leaving a void.

Weak bonds look alike after the joint fails. While there is usually a good chance that the failure is caused by poor cleaning, a thorough check of solutions and shop procedure might eliminate cleaning as a cause. This means that you should look for other causes of bond failure. These are:

- Improper proportions of resin and hardener or incomplete mixing of a two-part adhesive.
- Surface contamination after cleaning by dust or vapor from other nearby shop operations.
- Incomplete curing of the adhesive before loading the joint or improper joint design.
- Solvent entrapment when parts are bonded before the solvent evaporates. In nonporous materials the solvent remains in the adhesive and prevents it from completely drying or curing. In plastics, the solvent will migrate to the surface of the part and weaken the bond.

For REPRINT of above article, just check 623 on one of the Reader Service cards found in this issue.

EDITOR'S NOTE: Other recent articles on new adhesive materials and how to design the joints for them:

Now . . . Pre-shaped Epoxy Adhesives, May 22 '61, p 43—Preformed adhesive pellets shaped to fit the joint contain just the right amount of joining agent.

These Parts Carry Their Own Adhesives, Mar 2 '59, p 57—Simple hand pressure does the bonding when the parts have their own pressure-sensitive adhesives. Just peel off the backing sheet and press in place.

Stresses in Adhesive Joints, July 7 '58, p 64—Six basic joint designs and how to calculate stress concentrations in each.

Sandwich Panel Adhesives, May 26 '58, p 56—Concluding part of a 3-part series on sandwich-panel materials describes and compares the 14 most widely specified adhesives.

Today's Rules for Rubber-to-metal Bonding, Aug 3 '58, p 52—This adhesive-bonding technique will join almost any metal to nearly any kind of rubber. Gives cleaning treatments for reliable bonds and tolerances that can be obtained.

Which Adhesive for What, Mar 17 '58, —Reference guide to the many different adhesives and how to apply them.

Single-component Epoxy Adhesive, May '57, p 104—Covers strength and curing data for paste adhesive requiring no hardener.

Adhesives for High-temperature Applications, Mid-Oct '58, p G25—Several types of epoxy resins adhesives are evaluated for different loading conditions.

—Herbert Kee

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■ Beam deflections are usually found by the solution of the second order differential equation of the lastic curve:

$$\frac{d^2y}{dx^2} = \frac{M}{EI} \qquad (1)$$

This equation can be solved by double integration if M/EI can be expressed as a continuous integrable function of x. When the cross-section is not constant, separate second-order differential equations must be written for each discontinuity. The solution of n such equations results in $2n$ simultaneous equations which must then be solved for the constants of integration.

Various available methods tend to minimize the tedium involved in solving the differential equations. However, the method of finite differences developed by the authors offers greater simplification without sacrificing accuracy. Solution of sample problem shows how it compares with the two other methods.

Method of finite differences

The differential Eq (1) can be replaced by equivalent finite differences:

$$\frac{dy}{dx} \approx \frac{\Delta y}{\Delta x} \approx \frac{(y_{n+1} - y_n)}{\Delta x}$$

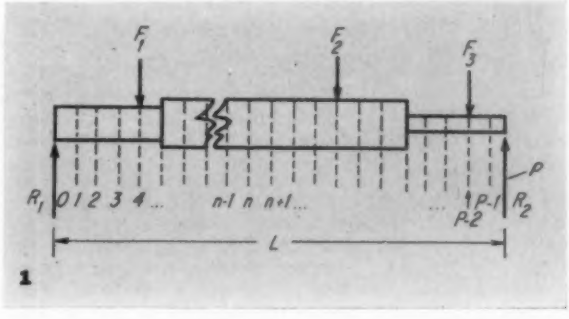
which gives

$$\frac{d^2y}{dx^2} \approx \frac{\left(\frac{y_{n+1}-y_n}{\Delta x}\right) - \left(\frac{y_n-y_{n-1}}{\Delta x}\right)}{\Delta x} \approx \frac{y_{n+1}-2y_n+y_{n-1}}{(\Delta x)^2}$$

Substituting this in Eq (1):

$$\frac{M_n}{E_n I_n} = \frac{y_{n+1} - 2y_n + y_{n-1}}{(\Delta x)^2}$$

$$y_{n+1} = 2y_n - y_{n-1} + \frac{M_n (\Delta x)^2}{E_n I_n} \qquad (2)$$



1

This is the basic equation which can be used to determine the deflection of a beam of varying cross-section, composition, or load (see Fig 1). The idea is to divide the beam into an arbitrary number of equal increments, each of length L/P where L is the total length of the beam and P the total number of increments.

To simplify the equations let

$$K_n = \frac{M_n(\Delta x)^2}{E_n I_n}$$

In these equations n is any value of interest i from 1 to P, and Eq (2) then can be tabulated in a series of equations:

$n = i$	Equation	No.
-1	$y_0 = 2y_{-1} - y_{-2} + K_{-1}$	(a)
0	$y_1 = 2y_0 - y_{-1} + K_0$	(b)
1	$y_2 = 2y_1 - y_0 + K_1$	(c)
2	$y_3 = 2y_2 - y_1 + K_2$	(d)
3	$y_4 = 2y_3 - y_2 + K_3$	(e)
⋮	⋮	⋮
$P-1$	$y_P = 2y_{P-1} - y_{P-2} + K_{P-1}$	(f)
P	$y_{P+1} = 2y_P - y_{P-1} + K_P$	(g)
$P+1$	$y_{P+2} = 2y_{P+1} - y_P + K_{P+1}$	(h)

The tabulated equations (c) to (f) can be rearranged and

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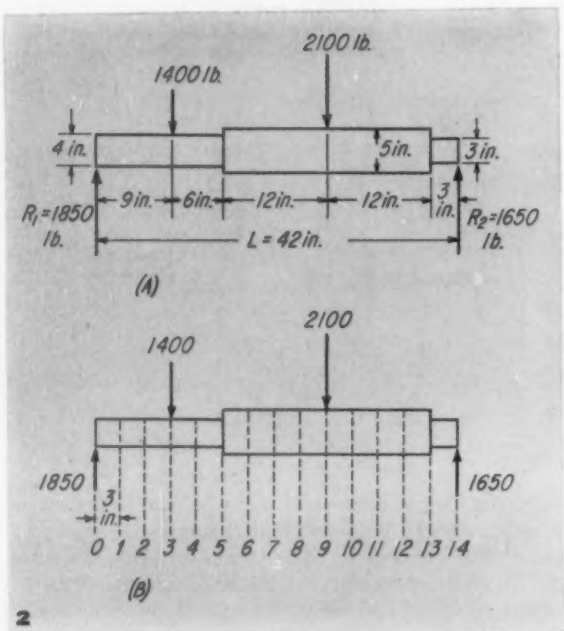
i	M_i lb-in.	I_i in.^{4}	$(P-i)$	$(n-i)$	$M_i(P-i)$ lb-in.	$\frac{M_i(P-i)}{E_i I_i}$	$M_i(n-i)$ lb-in.	$\frac{M_i(n-i)}{E_i I_i}$
0	0	12.57	14	9	———	———	———	———
1	3,550	12.57	13	8	72,150	1.913×10^{-4}	44,000	1.177×10^{-4}
2	11,100	12.57	12	7	133,200	3.532	77,700	2.060
3	16,650	12.57	11	6	183,150	4.857	99,900	2.649
4	18,000	12.57	10	5	180,000	4.774	90,000	2.387
5	19,350	21.63	9	4	174,150	2.684	77,400	1.193
6	20,700	30.68	8	3	165,600	1.797	62,400	0.675
7	22,050	30.68	7	2	154,350	1.676	44,100	0.479
8	23,400	30.68	6	1	140,400	1.525	23,400	0.254×10^{-4}
9	24,750	30.68	5	0	123,750	1.344	———	———
10	19,800	30.68	4	—	79,200	0.860	———	———
11	14,850	30.68	3	—	44,550	0.484	———	———
12	9,900	30.68	2	—	19,800	0.215	———	———
13	4,950	17.33	1	—	4,950	0.095×10^{-4}	———	———
14	0	3.98	0	—	———	———	———	———

$\Sigma = 25.756 \times 10^{-4}$ $\Sigma = 10.874 \times 10^{-4}$



2

solved simultaneously for y_1, assuming deflections y_0 and y_p are zero. This solution can be expressed by a determinant, or better still by the summation:

$$y_1 = -\left(\frac{1}{P}\right) \sum_{i=1}^{i=P-1} K_i (P - i) \qquad (3)$$

The tabulated equations (c) and (d) can be combined to give:

$$y_3 = 3y_1 + 2K_1 + K_2$$

Similarly:

$$y_4 = 4y_1 + 3K_1 + 2K_2 + K_3$$
$$y_5 = 5y_1 + 4K_1 + 3K_2 + 2K_3 + K_4$$
$$y_n = ny_1 + (n-1)K_1 + (n-2)K_2 + \ldots + 2K_{n-2} + K_{n-1}$$

This last equation can be expressed by the summation:

$$y_n = ny_1 + \sum_{i=1}^{i=P-2} (n - i) K_i \qquad (4)$$

Now Eq (3) and (4) can be combined to give:

$$y_n = -\frac{n}{P} \sum_{i=1}^{i=P-2} K_i (P - i) + \sum_{i=1}^{i=n-1} (n - i) K_i$$

Substituting for K_i and rearranging gives the following general equation which can be used to find the deflection at any point in a complex beam:

$$y_n = \left(\frac{L}{P}\right)^2 \left[-\frac{n}{P} \sum_{i=1}^{i=P-1} \frac{M_i(P-i)}{E_i I_i} + \sum_{i=1}^{i=n-1} \frac{M_i(n-i)}{E_i I_i} \right] \qquad (5)$$

Example

Find the deflection of a steel shaft at a point under the 2100-lb load (Fig 2). The modulus of elasticity, $E = 30 \times 10^6$ psi.

Solution

Divide the shaft into 14 three-inch increments and number them. For Eq (5) the following factors are known: $L = 42$ in. $P = 14$, $n = 9$, $E_i = 30 \times 10^6$. The only unknown factors are M_i and I_i, which can be solved in the usual way and tabulated as shown above.

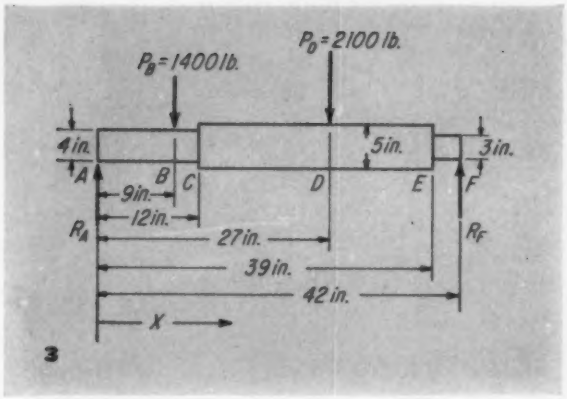
Substituting the values from table in Eq (5) gives:

$$y_n = \left(\frac{42}{14}\right)^2 \left[-\frac{9}{14} (25.756) + (10.874) \right] (10^{-6})$$

$$y_n = 0.005{,}116 \text{ in.}$$

Solution by other methods

Two other methods are of particular interest as a comparison to the method of finite differences. The first is known as Castigliano's method which is based on the elastic energy in the beam (see Strength of Materials, by F R Shanley, p 30). A variation of this method is known as the Least Work method which is used to solve for unknown reactions in statically indeterminate structures.



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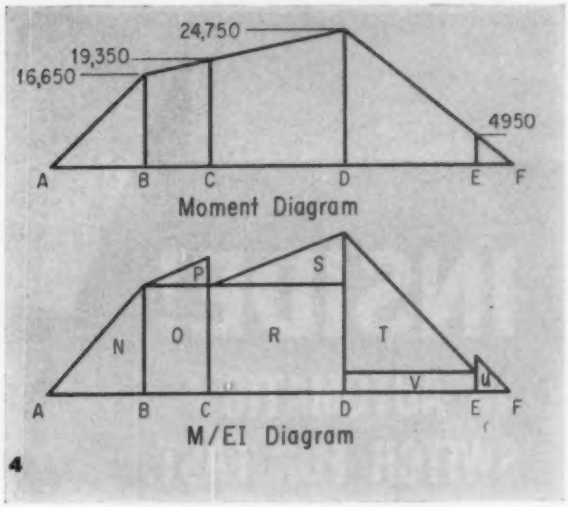

4

Castigliano's method is used to find deflections. In the Least Work method the partial derivative with respect to some unknown fixed reaction is set equal to zero. Since the movement of the reaction is zero, this is the same as applying the Castigliano method to some load which does not cause a deflection. When it is desired to find the deflection of some point under a load the method of virtual work is employed. For virtual work a fictitious load is employed.

The second method of interest is the Moment-area method which is useful for concentrated loads where the beam consists of a series of sections each having a constant moment of inertia. However, this method is limited to cases where areas and centroidal distances can be found easily, that is, when the moment diagram can be divided into triangles and rectangles.

Solution of the above example by these two other methods gives a true comparison with the finite difference method.

Solution by Castigliano's Method

Dividing the beam into convenient sections (Fig 3) the first step is to determine the moments for each of the sections. Using Castigliano's theorem the deflection under the loads is derived from the elastic energy equation:

$$U = \int_0^L \frac{M^2\,dx}{2\,EI}$$

which gives

$$\Delta_B = \frac{U}{P_B} = \frac{\partial}{\partial P_B}\int_0^L \frac{M^2\,dx}{2\,EI} = \int_0^L \frac{M\,\dfrac{\partial M}{\partial P_B}}{EI}\,dx$$

Similarly $\Delta_D = \displaystyle\int_0^L \frac{M\,\dfrac{\partial M}{P_D}}{EI}\,dx$

To find deflections Δ_B and Δ_D, the terms $\partial M/\partial P_B$ and $\partial M/\partial P_D$ must be found for each of the sections. This involves solution of a number of integral equations which eventually give $\Delta_B = 0.004{,}507{,}7$ in.; $\Delta_D = 0.005{,}196$ in.

Solution by Moment-area Method (Fig 4)

This method gives an easy solution in this particular case, because the moment diagram is can be divided into triangles and rectangles quite readily. Once the moments and areas are determined, the deflection under P_D results in $\Delta_D = 0.005{,}201$ in.

Summary of solutions

Finite differences	$y_a = 0.005{,}116$ in.
Castigliano	$\Delta_D = 0.005{,}196$ in.
Moment-area	$\Delta_D = 0.005{,}201$ in.

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EDITOR'S NOTE: For additional information on stress analysis see:

How to Analyze Deflections of Sleeved Shafts, Apr 17 '61, p 60—Gives a practical method that takes composite-beam theory a step further and includes the effect of interference fits.

New Equations for 5 Tapered Cantilever Beams, July 25 '60, p 52—Shows how economical tapered beams can be used without necessity of solving differential equations to find stresses and deflections.

Faster Stress Analysis of Combined Loads on Beams, May 16, '60, p 97—Author's method presents solutions to differential equations in the form of charts and easy to use algebraic equations. They are applicable to simple beams and can be extended to beams with complex loads, as well as statistically indeterminate beams.

Critical Frequency of Stopped Shafts, Jan 11 '60, p 57—Gives equations for frequency and critical speed for plain round, or tubular, rectangular and odd-shaped stepped shafts.

Conjugate Beam Method, Aug 18 '58, p 83—Gives four examples of application to load problems.

Finding Stresses in a Pressure-vessel Head, July 6 '59, p 57—Method uses strain gages, all located on outside of vessel, yet accurately determines biaxial stresses at joint of shell and head.

For a Stronger Metal Surface, Nov 14 '60, p 70. Here's a practical guide that compares different methods of boosting wear resistance, bearing and fatigue strength.

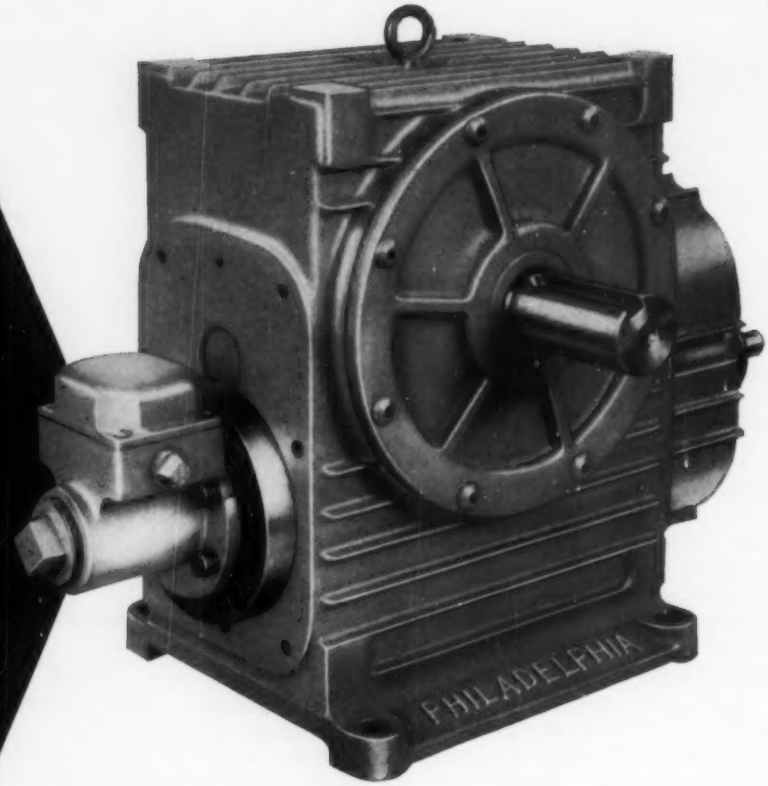
Allowable Stresses in Flash-welded Joints, Oct 31 '60, p 39. Shows how flash welding can produce joints as strong as the parent metal, and how to correlate data with magnetic inspection to keep the flaws due to mass production at a low percentage.

Reserve Strength in Metal Parts, Dec 21 '59, p 45. Shows how to exceed the yield strength of a material and get away with it by designing in the plastic range. Tables and two sample problems with concise explanation of author's method leads to most economical design.

—Frederick Marich

INSIDE!

AN AUTOMATIC SWITCH FOR FAST, SURE PROTECTION AGAINST OVERLOAD

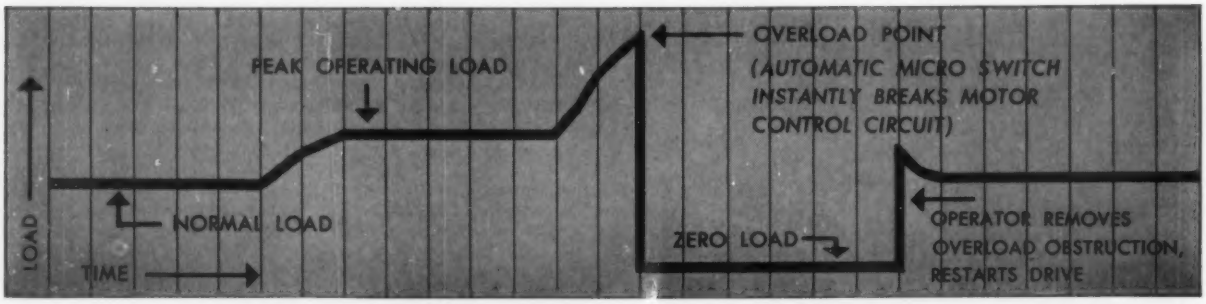


Here is instant protection against overload damage . . . Philadelphia Gear's Torque Control for worm gear reducers. When output torque of the reducer exceeds a pre-set value, the control breaks the motor control circuit—instantly. This is accomplished by mechanical actuation of an electrical line break switch. Truly foolproof protection for driving and driven equipment.

Time saved with Torque Control can be considerable, too. For example, you can remove the cause of overload or jam immediately. There is no waiting for heaters to function or for shear pin replacement. In short, downtime is either drastically cut or eliminated.

How about starting surge? Here, too, is an advantage . . . the control can be by-passed by holding the START push button to permit this temporary overload. Torque Control is optional on Phillie Gear equipment, and is available for either one direction of operation or both.

For information on our complete line of Worm Gear Reducers, write for catalog WG-60.



philadelphia gear drives

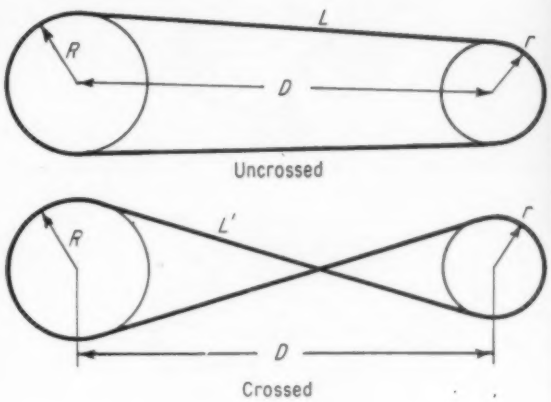
PHILADELPHIA GEAR CORPORATION

King of Prussia (Suburban Philadelphia), Pennsylvania

TAPE MEASURE FOR PULLEY BELTS

Nomographs unsnarl long equations for lengths of crossed and uncrossed belts.

CMDR S R HELLER JR, *USN*
Portsmouth Naval Shipyard
Portsmouth, NH



■ What looks like a simple geometrical problem, finding the length of a belt around two pulleys, turns out to involve unwieldy equations. When the belt is crossed, the equation is:

$$L' = 2D\left[\frac{\pi\,(R+r)}{2D} + \sqrt{1-\left(\frac{R+r}{D}\right)^2} + \left(\frac{R+r}{D}\right)\sin^{-1}\left(\frac{R+r}{D}\right)\right].$$

When the belt is uncrossed, the equation is:

$$L = 2D\left[\frac{\pi\,(R+r)}{2D} + \sqrt{1-\left(\frac{R-r}{D}\right)^2} + \left(\frac{R-r}{D}\right)\sin^{-1}\left(\frac{R-r}{D}\right)\right].$$

Now see how easy the nomograph makes the solution.

EXAMPLE: An uncrossed belt passes around pulleys 8 in. and 4 in. in diameter. If the center-to-center distance between the pulleys is 20 in., how long is the belt?

Solution: $(R + r)/D = (8 + 4)/20 = 0.6$ $(R - r)/D = (8 - 4)/20 = 0.2$. With this information and knowing that $D = 20$, draw two lines on the nomograph, as shown, to find length $L = 78.5$ in.

It is difficult to calculate pulley radii for a set of stepped pulleys when the belt is uncrossed, because both $(R + r)$ and $(R - r)$ change from one pulley combination to another. In contrast, the same calculation is easy with a crossed belt, since $(R + r)$ stays constant and $(R - r)$ doesn't enter into the problem at all. However, even the uncrossed belt problem is easy with the nomograph.

For instance, let's say we wanted to add other pulleys of different ratios to the pair above. D is the same, and L doesn't change, so the intersection of line 2 with the vertical pivot stays fixed. It is necessary only to rotate a straight edge around the point of intersection to find all the combinations of $(R + r)$ and $(R - r)$. In this case all possible combinations lie between $(R - r) = 0$, which is a ratio of infinity, and $(R - r) = 0.58$ where $(R - r) = (R + r)$ for a ratio 1:1.

SYMBOLS

D = Center-to-center distance between pulleys, in.
L = Length of an uncrossed belt, in.
L' = Length of a crossed belt, in.
R = Radius of larger pulley, in.
r = Radius of smaller pulley, in.

Note that the nomographs work equally well with any units as long as they are consistent.

INFORMATIVE NOTES TO IMPROVE YOUR PRODUCT ...SAVE YOU MONEY

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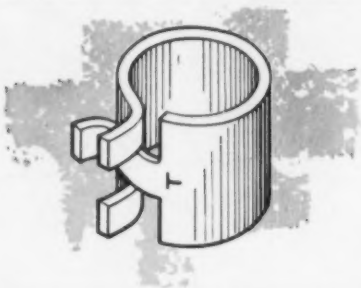
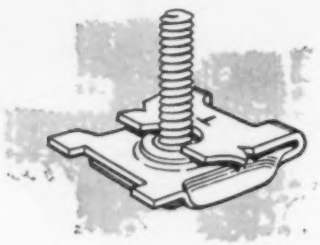
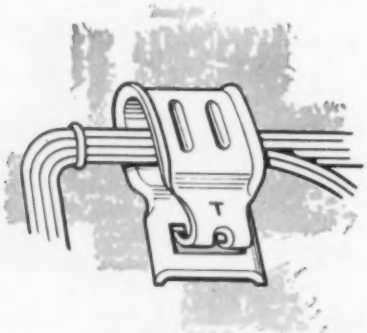


VERSATILE COMPRESSION RING has solved fastening problems in car radios, pressure gages, washers, and speaker cabinets. Simply squeeze compression fingers with pliers to expand . . . release, and spring tension maintains firm connection. Heat-treated spring steel of this SPEED CLIP® fastener won't lose tension, won't loosen under vibration. Possible applications are practically unlimited.



BOLT RETAINER used to fasten grille extensions to car fenders, has potential usage in any field where high-torque fastening is required on thin metal sections. This SPEED GRIP® fastener eliminates costly welding or staking, speeds assembly, allows savings in labor costs and parts handling. Barbs locate fasteners until nut is driven. One of Tinnerman's extensive line of SPEED GRIP nut and bolt retainers.

ELECTRONIC CONTROL CLIP retains tuning switch on chassis, gives constant spring tension for both push-pull and revolving controls . . . can be used wherever electronic controls are installed. This multipurpose SPEED CLIP fastener replaces threaded nuts, bushings, lockwashers. Cuts costs substantially. Live spring action lasts for the life of the equipment.



WIRE RETAINER is ideal for attaching single wire, light harness, cables or tubing. This SPEED CLIP fastener can be preassembled on the harness, allowing an entire wiring system to be snapped into place in seconds. Double embosses on upper clamping leg trap cold-flow tendencies of vinyl covered cord, assure 35 pound pull resistance. Clip will accept any wire or bundle up to .306" x .515".

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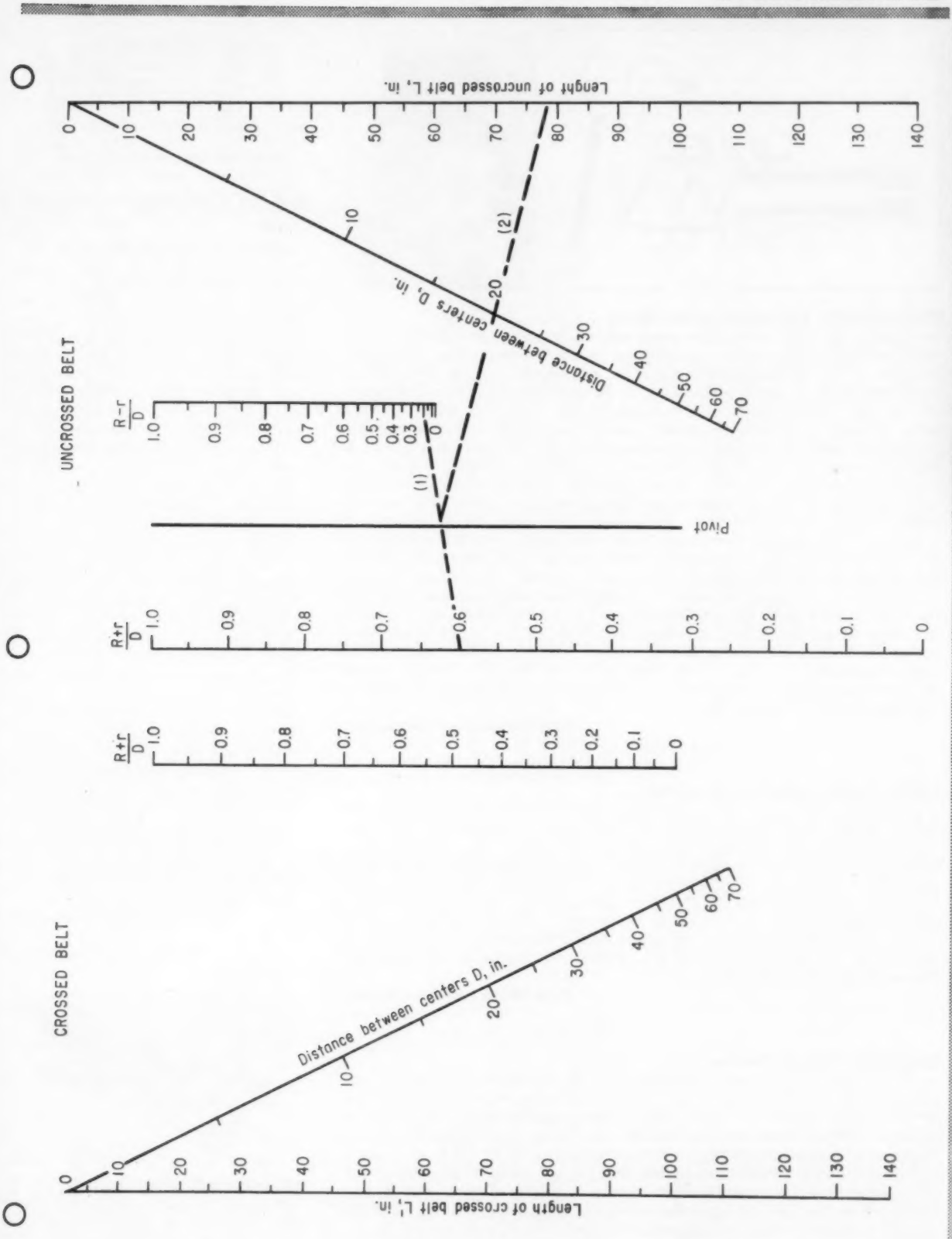
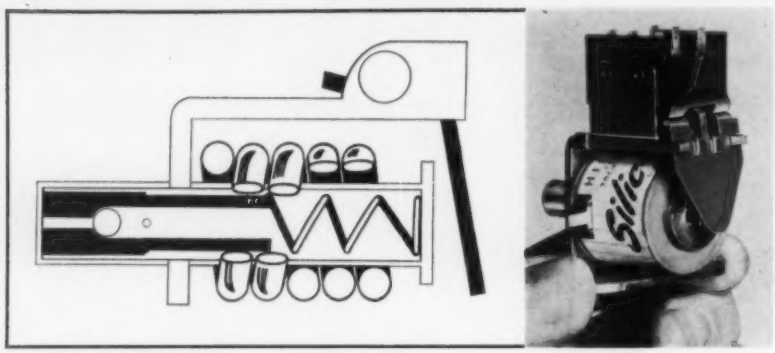

Length of uncrossed belt L, in.
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
Distance between centers D, in.
10 20 30 40 50 60 70
(2)
(1)
UNCROSSED BELT
R−r / D
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0
Pivot
R+r / D
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0
R+r / D
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0
CROSSED BELT
Distance between centers D, in.
10 20 30 40 50 60 70
Length of crossed belt L, in.
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140



Hydraulically controlled time delay . . .

has hermetically sealed, nonmagnetic metal tube which extends through and beyond the solenoid coil. Tube contains a movable iron core, a core-return spring and silicone liquid fill. When coil is energized, iron core is drawn into the magnetic field. Silicone liquid slows its travel, providing time delay. As the core moves into the coil, it reduces the "air" gap, lowering reluctance in the magnetic field. When core touches the pole piece, the magnetic circuit is completed, creating a considerable increase in magnetic flux, which is sufficient to attract the armature and actuate the relay contacts. When relay is de-energized, core returns under spring pressure to its original position (see cross-section, above). On return, a tiny ball-type check valve within the core opens, allowing the silicone liquid to pass through the core's center. The unit has totally enclosed snap-action contacts, which cannot be contaminated by environment or tampered with. Switches up to 5-amp loads, either SPDT or DPDT, and has continuous-duty coil, allowing it to function as both delay device and load relay. Also has balanced armature structure which confines armature to either of two discrete positions so that there is no chance of tentative actuation—even under moderate shock and vibration. Available in 16 standard timings from ½ to 120 sec and for either standard ac voltages from 6 to 240 v or dc voltages from 4 to 120 v. Contact capacity is 5 amp at 125 or 250 v ac; 5 amp at 30 v dc, resistive; 3 amp at 30 v dc, inductive. Max power consumption is 2 w ac, 3 w dc. Measures 2.1 x 1.8 x 2.1 in.; weighs 3.5 oz. Pilot quantities available in late August or early September. **Heinemann Electric Co, 378 Magnetic Dr, Trenton 2, NJ.**

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100% grain-oriented magnet . . .

is of Alnico-type alloy and has nominal energy product of 7.5 million gauss-oersteds. Said to produce more magnetic energy per unit volume or weight than any other variation of Alnico magnets now available, the new material is produced in two grades: USM76 has nominal energy product (BH) of 7.5 million gauss-oersteds, residual induction (BR) of 13,900 gauss, coercive force (HC) of 750 oersteds; USM65 has a BH of 6.5 million, BR of 13,500 and HC of 650. Weight per cu in. of both materials is 0.265 and mechanical properties are hard-brittle. Per-lb costs of the new material are higher, but it is claimed that magnets of energy ratings equal to those of conventional materials will be about the same in price. Now in production. **US Magnet & Alloy Corp, 266 Glenwood Ave, Bloomfield, NJ.**

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Extension swivel fitting . . .

for fluid systems, is a straight-through assembly with one end that rotates 360° and extends a full 6 in. This is said to be useful in applications where two sections of a fluid line system must be connected and then drawn together to be sealed within an enclosure. Fitting's linear movement also provides built-in compensation for thermal expansion and contraction. Operates at temperatures from —65 to 300 F and pressures to 5000 psi. Unit is pressure-balanced, and, therefore, not subject to separation forces. Also prevents tube stresses resulting from twisting or turning. Pressure drop in ¼-in. tube size is less than 5 psi at 1.2 gpm flow of MIL-H-5606 hydraulic fluid at 70 F. Force required to extend or retract rotating end is less than 8 lb when not pressurized; less than 14 lb at 3000 psi. Available in various configurations, sizes and fitting ends. **Dumont Engineering Co, 1401 Freeman Ave, Long Beach 4, Calif.**

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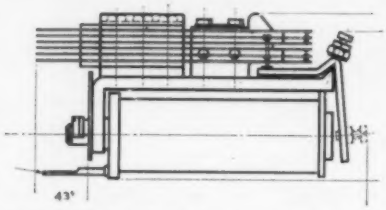
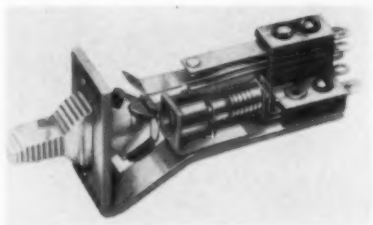


Relay's knife-edge armature pivot . . .

is said to eliminate air gap in its magnetic circuit. Resulting increased sensitivity reduces pull-in power to 20 to 350 mw, depending on spring load, or permits an operating time of 3 to 5 millisec for light spring load and high permeability magnetic core. Relay also can be fitted with a special "remanent" magnetic core of carbon steel so that it is held closed by a remanent field when supply is removed (said to be useful in low-cost memory and logic circuits or where power must be conserved once relay is energized). Remanent core needs only a short pulse of current to attract the armature, which then is held in by remanent magnetism until a reverse pulse cancels the magnetism to release it. Energizing and de-energizing circuits can be electrically isolated since relay accommodates 4 windings. Can be supplied with up to 10 sets of double-throw contacts; is capable of being operated at 650 v, can interrupt 10-amp loads and use 100,000-ohm coils. Also can incorporate time-delay feature, hermetically sealed case, bifurcated contacts, etc. Suitable for logic and control applications, since switching and logic circuits can be designed with one relay type instead of wide assortment. Unit with 6 form-C double-throw bifurcated contacts is priced at approx $5.20 each in lots of 100, depending on coil voltage requirements. Delivery in 6 to 12 wk. **Ellis & Frowd, Dept R, PO Box 549, Times Square Station, New York 36.**

Circle 303 on Reader Service Card



Illuminated lever switch . . .

color codes switching positions and functions. Replaces an ordinary switch and up to three indicator lamps, cutting control panel cost and space requirements by at least 40%. Incorporate long-frame,

leaf-type switching, unit is available in 2- and 3-position, locking and nonlocking types. Uses one 6 or 28 v lamp for high-impact illumination in red, green, amber or white (other colors on request). Mounts on $\frac{3}{8}$-in. center in panels up to $\frac{1}{16}$ in. thick; requires only $2\frac{3}{8}$-in. depth behind panel. Contacts (silver is standard, palladium on request) are rated 3 amp or 300 w max noninductive ac load. **Switchcraft Inc, 5555 N Elston Ave, Chicago 30.**

Circle 304 on Reader Service Card

Plastic journal bearings . . .

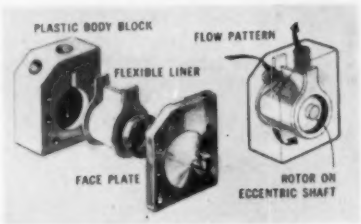
operate at temperatures up to 600 F and at extremely low temperatures, in the cryogenic range. Made of reinforced Teflon, they are designed for use where lubrication is impossible or undesirable. Dirt, fibers or debris reportedly will not adhere to them. Bondable to metal, (particularly dead soft grades) they can be used to replace worn inserts in existing machinery or can be used without a metal backing as original equipment. Thermal expansion is said to be equivalent to aluminum, while no cold-flow problems and no effect by moisture on dimensions is claimed. Available in conventional bearing sizes. **Rogers Corp, Rogers, Conn.**

Circle 305 on Reader Service Card

Temperature monitor . . .

is a fail-safe unit which limits excursion of temperature between two preset limits. When temperature limit is reached, chamber in which devices are being tested is automatically turned off and cannot be turned on without manual reset of the monitor. If a heat generating device, such as a motor or electronic capsule, is being tested and an overheat condition is reached, device can be turned off in same manner. Monitor also serves as a pyrometer to indicate temperature of the test device at any given time. Includes a signal light to indicate operation and an alarm light to indicate a dangerous condition. Available to control spans as small as 20 F between over-all limits of —100 and 500 F, or with over-all spans from —100 to 1000 F (higher over-all spans supplied on request). **Delta Design Inc, 3163 Adams Ave, San Diego 16, Calif.**

Circle 306 on Reader Service Card



Plastic pump . . .

has no stuffing boxes, shaft seals, valves or gaskets. Measures only 6 x 8 x 11 in. and is designed for vending machines, plating equipment, lube-oil service, bottle fillers and lab equipment. Pumping is accomplished by a rotor on an eccentric shaft, which turns within a flexible liner. This creates a progressive "squeegee" action on fluid trapped between the synthetic liner and plastic body block. No rotating part or metal contacts the fluid. Pump is self-priming, operates wet or dry, and handles slurries and viscous materials. Available in capacities from $\frac{1}{4}$ to 10 gpm and pressures to 35 psia. Standard materials are neoprene for the liner and linear polyethelene for the body block (other materials such as polyvinyl chloride, Teflon, Buna N, Kel F and Hypalon available on request). Said to be low in cost. **Vanton Pump & Equipment Corp, Hillside, NJ.**

Circle 307 on Reader Service Card

Differential brake valve . . .

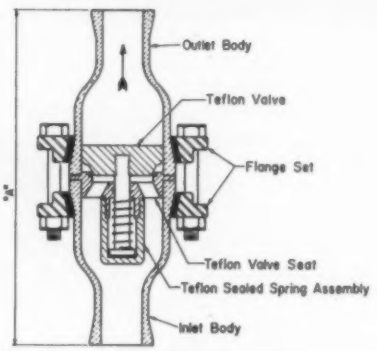
eliminates need for costly nonslip differential on materials handling, mobile and off-the-road vehicles. Has two normally open, spring return, two-way valves with a common pressure port to which master brake cylinder is connected. Each of the two cylinder ports is connected to a brake cylinder of one of the two drive wheels of a vehicle. Depressing a pushbutton shuts off flow of brakes fluid to wheel having traction if one drive wheel is spinning. Brake pedal then can be depressed to lock spinning wheel only. This enables vehicle to proceed under its own power with one wheel driving until both wheels again are in traction. Unit is designed for use with hydraulic oils or brake fluids and can be installed in any hydraulic brake system. **Sarasota Precision Products Inc, Sub of Racine Hydraulics & Machinery Inc, 5757 McIntosh Rd, Sarasota, Fla.**

Circle 308 on Reader Service Card

General purpose relays . . .

have combination solder-push-on terminals which appear on one barrier type panel. This arrangement is said to facilitate use of the relays in printed circuit assemblies. Clear plastic enclosures allow above- and below-chassis and plug-in connections. In most, terminal panel is integral with relay, the cover merely fastening to the terminal panel. Units are 1-, 2- or 3-pole, single or double throw. Contacts and terminal are integral and contact area is inlaid with silver. Contact rating is 5 amp, 115 v ac or 32 v dc; coil voltages available up to 440 v ac or 230 v dc. Available versions include plate and latching types. Latter makes possible contact combinations as high as 6PDT. Many from stock. **Ohmite Mfg Co, 3672 Howard St, Skokie, Ill.**

Circle 309 on Reader Service Card



Spring-loaded check valve . . .

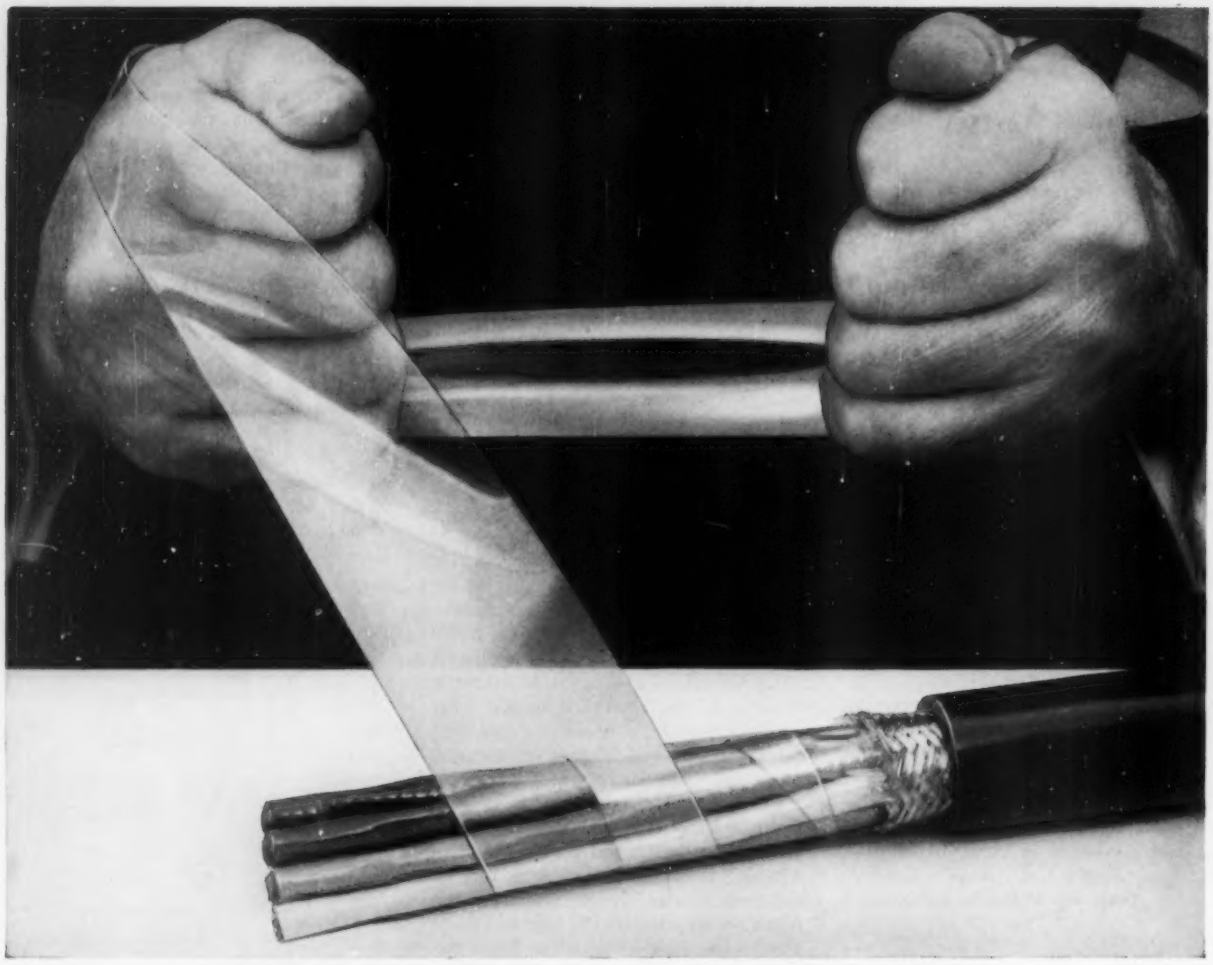
for horizontal and vertical mounting, has all Pyrex and Teflon construction, allowing full visibility with top corrosion resistance to all liquids except hydrofluoric acid and hot concentrated caustics. Stainless steel spring is sealed by a Teflon enclosure. Available in 1-, $1\frac{1}{2}$-, 2- and 3-in. sizes, adaptable to any pipe installation with 150-lb ASA companion flange. Max operating pressure is 50 psi, except for 3-in. valve, rated at 35 psi. From stock. **Chem Flow Corp, 136 Paterson Ave, Little Falls, NJ.**

Circle 310 on Reader Service Card

Drain valve . . .

can be mounted flush to any tank exterior surface and drains from within 0.020 in. of tank bottom to absolute bottom. Slight push with any blunt object the size of a lead pencil cracks the valve and permits fluid to drain. For extended or complete drainage, an upward push and slight rotation keeps valve in full-open position. There are no intermediate drip

continued on page 58



Tough tape of MYLAR® cuts cable costs . . . reduces size, weight

Can the unique combination of properties found in "Mylar" help solve your design problems?

Tensile strength of 20,000 psi . . . Bowling-ball test offers dramatic proof of the amazing strength and toughness of "Mylar" polyester film.

"Mylar"* polyester film is a tough, flexible engineering material. Used as a core binder tape for electric cable, "Mylar" prevents sharp braid wires from puncturing the primary insulation during cable manufacture. Replacing heavier, thicker materials formerly used, "Mylar" reduces size, weight, cost of cable.

In addition to its average tensile strength of 20,000 psi, "Mylar" has excellent resistance to most chemicals and moisture, a dielectric strength of 4,000 volts per mil for 1 mil film, and can withstand temperature extremes from –60° to 150°C.

On an area basis, tough, thin "Mylar" often costs less than heavier, conventional materials. "Mylar" can be laminated, embossed and metalized, punched or coated. The film won't become embrittled with age. "Mylar" is available in roll or sheet form in a wide range of gauges.

Find out how the combination of properties in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write today for our new booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room PE-8, Wilmington 98, Delaware.

*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

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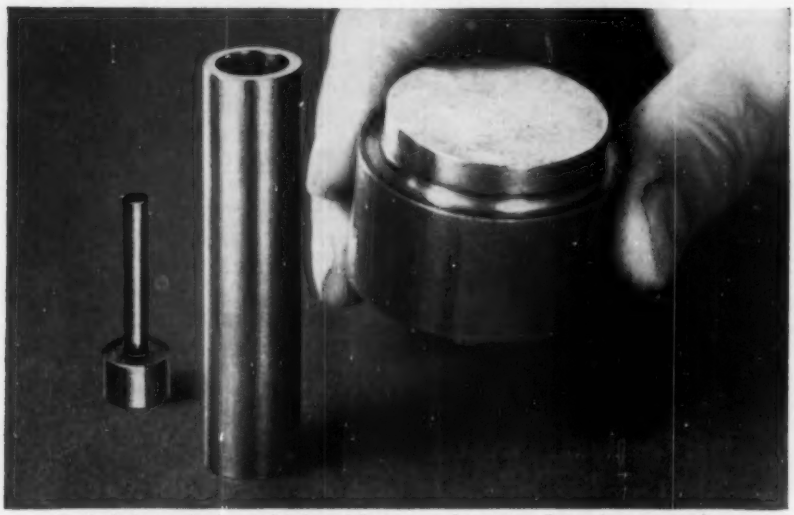
. . . THROUGH CHEMISTRY

DU PONT MYLAR POLYESTER FILM

Linde materials & coatings News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Crystal tungsten opens up a new era for the metal in electronics



Typical electronic shapes fabricated from crystal tungsten (l. to r.): target emitter; zero-porosity tungsten anode for high-powered electron tubes with fluid cooling; high-power vacuum switch contact of zero-porosity tungsten mounted to copper.

A new method of consolidating tungsten powder into tungsten ingot has been created by LINDE's Crystal Products Department. This new material—in crystal form—changes the whole approach to use of tungsten in electronic applications.

Compared to metallurgically prepared (PM) tungsten, crystal tungsten offers 5 to 15 per cent higher electrical conductivity. Thermal conductivity is about 20 per cent higher at 500°F., resulting in improved heat dissipation. These properties can be advantageous in electronic design.

Useful in vacuum devices

The high purity and zero porosity of the crystal tungsten also suggest its use not only in electrical contact points, but also in vacuum switches, electrical leadins in vacuum tubes, and applications where outgassing or leakage is a problem. Their purity and lack of grain boundaries provide more even electron emission, making them valuable in several high pressure vacuum or open air switches. Other uses include: flexible sheet in electronic tubes; x-ray and anticathode targets.

LINDE crystal tungsten is considerably more ductile than undoped PM tungsten. It can be drawn into wire as fine as 1 mil, giving greater yield of finished product from the starting ingot. Although undoped crystal tungsten has a lower recrystallization temperature, it does have a yield point at about 150°F.

Material easily worked

Significant is the fact that it can be easily worked and at temperatures 800°F. lower than working temperature for powder metallurgy or vacuum-arc cast tungsten—making it useful for a wide range of non-electronic applications. Present shapes include swaged rods from 1/10 to ⅜-inch diameter, as grown ingots up to ¾-inch diameter in production, and even larger diameters in development.

For more details on this new material, check the coupon below.

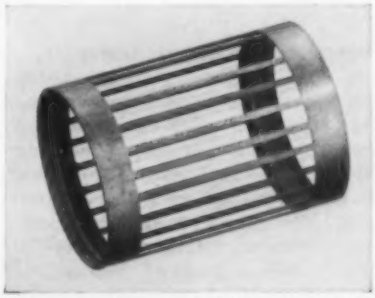
Super-hot process metal-coats and fabricates intricate parts

Dense, high-purity metal coatings for certain base materials, and the fabrication of odd shapes, are accomplished with "Plasmaplate," a super-hot plasma stream process developed by LINDE's Flame-Plating Department.

In operation, a high-current torch uses temperatures up to 30,000° F. to produce a supersonic stream of ionized gas—melt and accelerate to high velocity particles of any inorganic material that melts without decomposition.

High-purity coating materials—such as tungsten or other refractory metals—are thus permanently fused to the surfaces of materials such as graphite, brass, copper, steel, molybdenum, titanium, aluminum and others.

Parts of intricate configuration can be fabricated by depositing the coating material on a mandrel machined to the desired internal shape of the finished part. After the desired thickness is obtained, the mandrel is dissolved out by chemical means.



Tungsten grid cage—one of many complex shapes made by LINDE's "Plasmaplate" Process.

Thin coatings of tungsten carbide and other hard materials can also be applied to base metals by the LINDE oxyacetylene Flame-Plating "gun" process, to increase surface wear as many as 40 times.

For details on either of these LINDE processes, check the coupon below.

CHECK—CLIP COUPON—ATTACH TO BUSINESS LETTERHEAD

Linde Company, Dept. PG-82
270 Park Avenue
New York 17, N. Y.

Please send details on the items checked:

- ☐ LINDE Crystal Tungsten
- ☐ LINDE "Plasmaplate" Process
- ☐ LINDE Flame-Plating Process

UNION CARBIDE

LINDE COMPANY

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positions—valve either is intentionally full-open or positively closed. Secondary metal-to-metal seal holds seepage to a few drops an hr under most conditions should O-ring seal completely fail. From stock at price said to be considerably less than similar components. **Bruning Co, Lincoln, Neb.**

Circle 311 on Reader Service Card

Series-motor parts . . .

have one-coil-per-slot design, said to prolong commutator and brush life 2½ times. Design allows optimum combinations of 21 coils, 21 slots (3 7/16-in. dia frame) and 18 coils, 18 slots (2 7/16-in. dia frame). Field core is bonded with integral insulation, said to have four times the dielectric strength, three times the impact resistance and two times the cut-through resistance of conventional paper insulation. After integral insulation is applied and field wound, the entire field is dipped in a special epoxy varnish, and to limit entry of harmful carbon dust produced by normal brush wear, armature is coated with varnish. Coil leads are welded to the commutator though a process which does not require prior removal of lead insulation and which uses no foreign compound to secure the lead. Parts are rated 65 to 560 w, 12,000 to 15,000 rpm. **General Electric Co, Schenectady 5, NY**

Circle 312 on Reader Service Card

Temperature transducers . . .

have wound sensing elements of tungsten, platinum, copper, nickel and other materials which are protected by integral shields. Include static-to-low-flow, medium-flow, high-flow and enclosed probes. Having integral one-piece stainless steel construction, probes operate in practically any environment, withstand shock of 100 g for 11 millisec, pressure from 0 to 5000 psi, vibration of 20 g to 2000 cps. Also operate in most solid, gaseous or fluid mediums and over various ranges covering from —452 to 1750 F. Accuracy is said to be to 0.1% of range (accuracies to 0.01% can be had in special units). In most models, built-in connector simplifies installation, prevents moisture and other contaminants from entering body. **Temtro Inc, 3016-C S Halladay, Santa Ana, Calif.**

Circle 313 on Reader Service Card

Lighted pushbutton switch . . .

has 10-amp capacity at 125 or 250 v ac, 30 v dc, and provides one-button control of two separate circuits. Available with either momentary- or alternate-action design. Momentary-action design switches circuits as long as the pushbutton is depressed. When released, button returns to original position and circuit. With alternate-action design, pushed button remains in operated position. When it is pushed again, it springs back to original position. Lamp and switch terminals are separated for independent wiring. Incandescent bulbs, operating on 6, 12 or 28 v, do not move when switch is operated, reportedly reducing filament jarring and prolonging bulb life. Red, white, blue, green or yellow translucent buttons are available in four sizes and shapes. Contact arrangement of switch elements is two-circuit double-break. **Micro Switch Div, Minneapolis Honeywell Regulator Co, Freeport, Ill.**

Circle 314 on Reader Service Card

Fractional-hp motors . . .

with ratings of 1/40 to ½ hp, have varied load speeds from 2500 to 20,000 rpm depending on requirements. Voltage ratings range from 4 to 220 v, ac, dc or ac/dc. Diameter is 3 in. Length (excluding shaft) varies from 3 to 4¼ in., depending on hp required. Available with either steel or die cast case and recommended for pumps, vacuum cleaners, power tools, etc. **Heinze Electric Co, 685 Lawrence St, Lowell, Mass.**

Circle 315 on Reader Service Card

Two-way solenoid valve . . .

withstands vibration at 20-1000 cycles per sec at 10-g level without shifting position. Designed for normally closed operation (valve closes when solenoid is de-energized) at pressures to 1000 psi, unit is supplied in ⅜-in. NPT pipe size with brass body and seat and Viton A disk. Handles diesel fuel, kerosene and gasoline at temperatures from —65 to 150 F. Prices range from $50 each in quantities of 30 to $35 each in quantities of 1000. Delivery in 3 to 4 mo. **Automatic Switch Co, Florham Park, NJ.**

Circle 316 on Reader Service Card

Transistor-equipped timer . . .

includes interval timer, time-delay relay and cycling timer models. Full-scale time ranges are 0.1, 1, 10 and 100 sec; repeat accuracy, 1% of full scale. Control of all models is by sustained contact while interval timer and time-delay relay can be controlled by momentary contact. No warmup time is required, since no electronic tubes are used. Load contacts are double-make, double-break, rated 25 amp, 120 v ac resistive (or inductive with 75% power factor), with switching of two SPDT or four SPST circuits available. Load relay is plug-in type with mechanical life of more than 10 million cycles. Life of other elements is rated at more than 40 million cycles. All units, either panel or surface mounted, are supplied in NEMA 1 or weatherproof NEMA 4 enclosures. Power required is 115 or 220 v, 60 c. **Cramer Div, Giannini Controls Corp, Centerbrook, Conn.**

Circle 317 on Reader Service Card

Subminiature thermostat . . .

originally designed for counter-top appliances, fire warning devices, etc, is a low-cost, dustfree unit that responds quickly and accurately with a positive bimetal snap action. Copper alloy terminals are corrosion resistant, case is plastic, and contacts are gold plated. Operates in temperature range of —65 to 380 F. Temperature differential is 7 F; temperature tolerance, ± 2 F. Electrical rating is 2 amp, 125 v ac rms. Measures 0.600 in. OD and 0.375 in. over-all height. From stock. **Thermel Inc, 667 Elmwood Ave, Providence, R. I.**

Circle 318 on Reader Service Card

Remote angle counter . . .

produces an in-line digital display of angle at a remote location through rotation of its input shaft. Also drives an unlimited number of readouts without power amplification. Readouts can be located on front panels without need for visual access to case. Housing size is 25; length, 3 in.; accuracy and resolution, 0.1°; life, 10,000 hr at 200 rpm; range, 0-360° continuous; and power required, 28 v dc or ac. Priced at $500 with delivery in 8 wk. **Theta Instrument Corp, 520 Victor St, Saddle Brook, NJ.**

Circle 319 on Reader Service Card

Solid-state motor control . . .

drives a 1/20-hp motor directly from a 60-cps line. Shaft speed, indicated on a panel meter, is stabilized against changes in line voltage and load by a tachometer. Control reverses and dynamically brakes motor for fast stops. Shaft speed range is from 100 to 5000 rpm with max load torque of 10 oz-in. at any speed. Speed is said to remain constant within 2% regardless of load variation. Max power drain is 150 w. **Industrial Control Co, Central Ave at Pinelawn, Farmingdale, LI, NY.**

Circle 320 on Reader Service Card

Panel-mount fixed tachometer

has three switch-selected ranges and a full-range accuracy of 1%. Registers either rotating (in rpm) or belt speeds (ft per min. or in. per min.). Indicator scales are furnished accordingly. Requires approx 4¾ x 4¼ in. panel space plus convenient location for range selector switch. Pickup head

continued on page 60

ELIMINATE UNNECESSARY ASSEMBLY COSTS with

Replace improvised units with readily available precision cam followers.

McGILL®

CAMROL® BEARINGS

CF (Cam Follower) SERIES

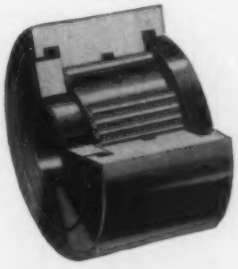
The original and still unsurpassed anti-friction roller bearing cam-follower bearing that adds efficiency at less cost to cam actuated, track and support roller applications. Built with full roller complement and integral stud, the CF series design provides high radial capacity and shock load protection in a compact roller with its own shaft. Easily applied and available in roller diameters of ½" to 4".

for the ultimate in:

- RADIAL CAPACITY
- SHOCK RESISTANCE
- SPACE ECONOMY

SCF SERIES.

Sealed to keep contamination out and lubricant in. It is dimensionally interchangeable with the CF bearings. A turned groove in the center of the outer raceway bore provides a permanent lubricant reservoir to approach life-time lubrication requirements. Can be easily re-lubricated.



SCYR SERIES (sealed)

CYR (Cam Yoke Roller) SERIES

The CYR series increases the adaptability of the CF bearing to all types of automatic machinery involving cam action or controlled-motion machine parts that require guide or support rollers. An inner ring replaces the stud for cam yoke roller mountings.

Write for Catalog No. 52-A for full information on McGill's needle roller bearings, and cam followers. Ask about recommendations for high precision special ball and roller bearings.

SCYR SERIES

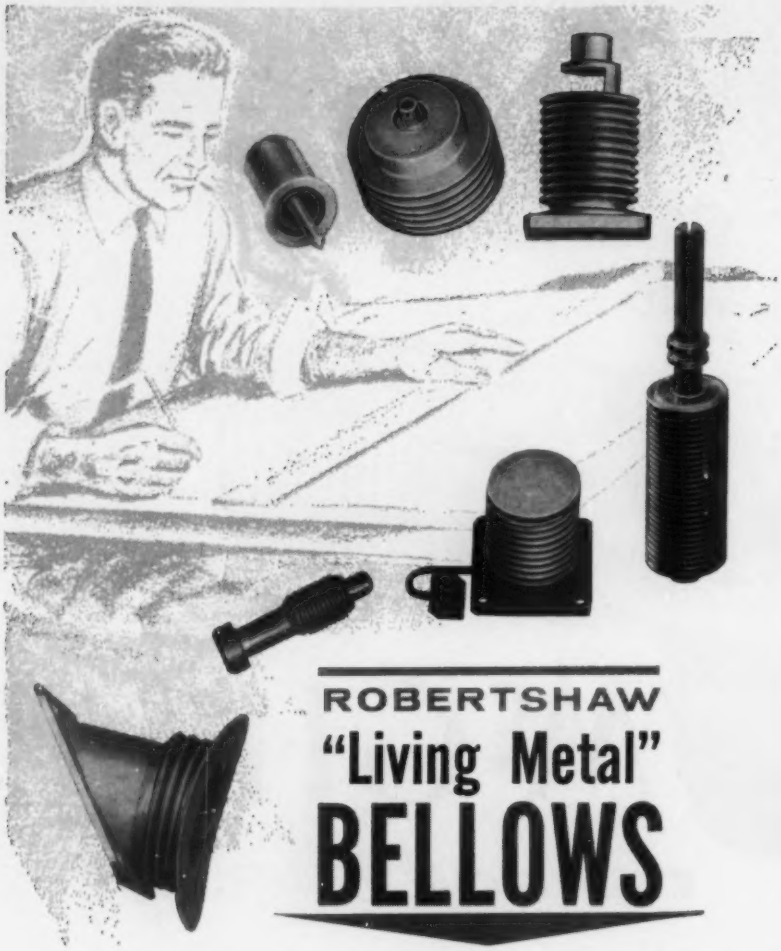
This series provides a fully sealed Cam Yoke Roller type bearing. It is dimensionally interchangeable with the CYR bearings.

engineered electrical products

McGILL®

precision needle roller bearings

McGILL MANUFACTURING CO., INC., Bearing Division
201 N. Lafayette Street, Valparaiso, Indiana



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...."the Design Engineer's Most Versatile Aid!"

As a DE you know the critical conditions of stress, temperature, pressure or atmosphere that make your problem so difficult . . . but you know the almost limitless versatility you can expect from Sylphon (R) Bellows by Robertshaw.

You know, too, that once you have worked out your exact requirements, our own bellows engineers can work closely with you to develop practical specifications and then carry the ball to final delivery.

Working with a variety of metals—brass, monel, beryllium copper, inconel, inconel-X, phosphor bronze, stainless steels, Ni-Span-C and others—they give you a bellows or bellows assembly with the precise, controlled expansion quotient your need demands.

Many Design Engineers call a Robertshaw Bellows their most dependable aid in aircraft, missile and process applications. Ours was the first seamless metal bellows ever made: today, we're still making the best.

For design data and tables of physical properties, write today for Catalog PP-R.

Robertshaw
Robertshaw-Fulton Controls Company
MR. CONTROLS

FULTON SYLPHON DIVISION, KNOXVILLE 1, TENNESSEE

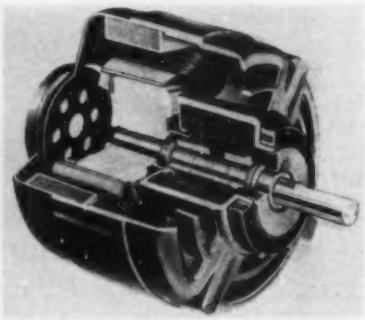
does its work as far as 1000 ft from indicator unit. Priced at $99.50, including pickup head and connecting cable. Single-range model, also available, is priced at $89.50 complete. Delivery in 1 wk for standard range models; 21 days for special modifications. **Metron Instrument Co, 5300 S Delaware, Littleton, Colo.**

Circle 321 on Reader Service Card

Five-spool control valve . . .

for mobile equipment, has a nominal rating of 12 gpm. Spools are either double-acting or "push" or "pull" for single action. Each has an individual load check and valve has an integral pilot-operated relief. Max recommended operating pressure is 2000 psi. **Parker Hydraulics Div, Parker-Hannifin Corp, 17325 Euclid Ave, Cleveland 12.**

Circle 322 on Reader Service Card



Fhp shaded-pole motors . . .

4 and 5 in. dia, use a forced-oil lubrication system that constantly recirculates, refilters and recools oil for max bearing life. Bearing wear is said to be eliminated during running by oil pressure from the hydrodynamic oil film bearing design. Integral insulation system uses an insulating resin that fuses the laminated stator core into an integrated unit, eliminates problem of wound-under wires and is impervious to humidity. Redesigned electrical punchings reportedly allow motors to deliver up to 20% higher efficiency than former models and also to contribute to a 25 to 30% lower winding temperature rise. Motors are rated from 0.015 to 0.10 hp, 60 c, 115 to 230 v. **General Electric Co, Schenectady 5, NY.**

Circle 323 on Reader Service Card

Preset counter . . .

adds or subtracts at speeds up to 100,000 counts per sec. Counting direction is controlled manually or with automatic electronic control by supplying input pulses to one of two control lines. Relay or pulse outputs initiate any desired action when

continued on page 62

Electrical Appliance

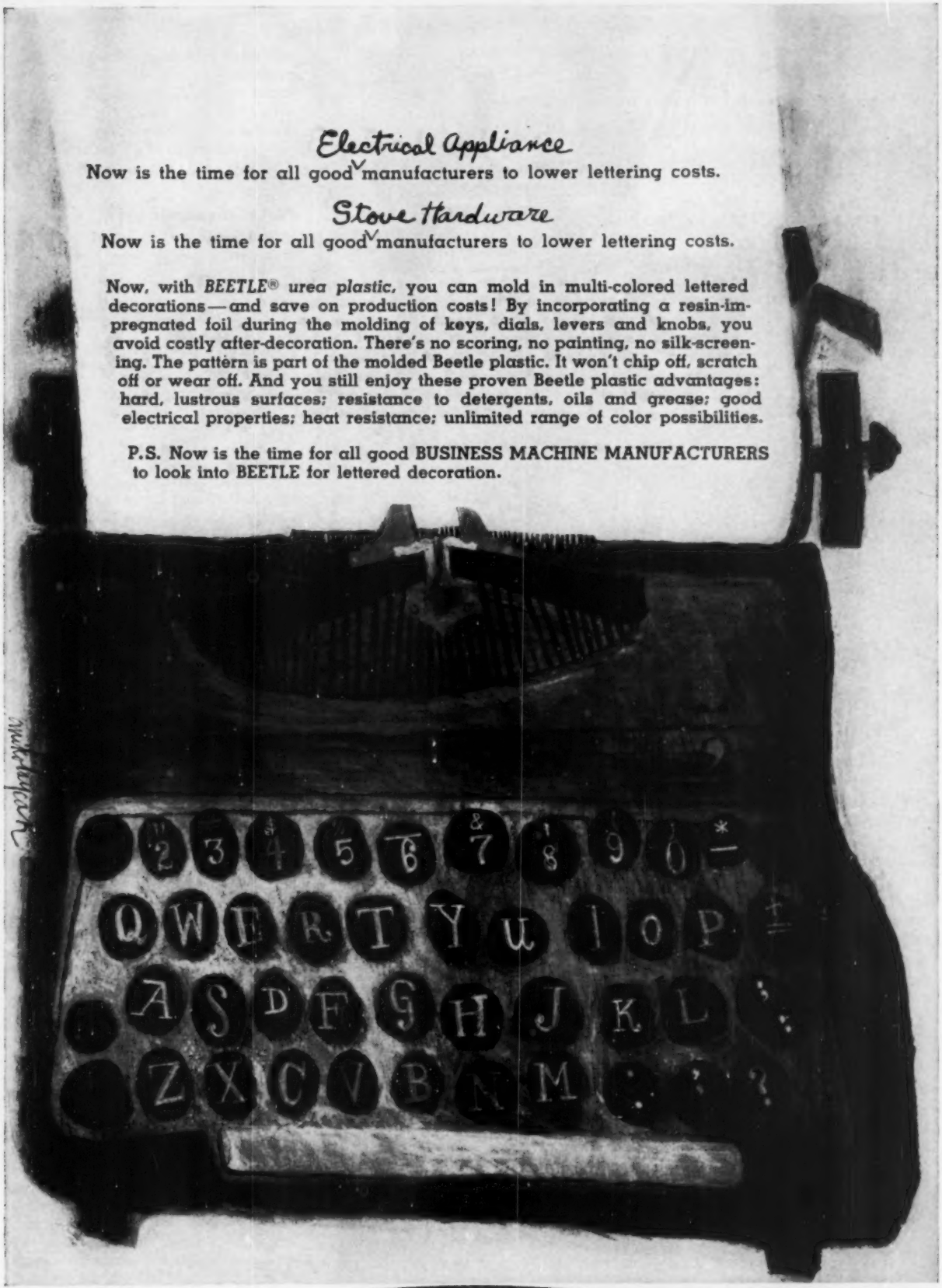
Now is the time for all good manufacturers to lower lettering costs.

Stove Hardware

Now is the time for all good manufacturers to lower lettering costs.

Now, with *BEETLE® urea plastic,* you can mold in multi-colored lettered decorations—and save on production costs! By incorporating a resin-impregnated foil during the molding of keys, dials, levers and knobs, you avoid costly after-decoration. There's no scoring, no painting, no silk-screening. The pattern is part of the molded Beetle plastic. It won't chip off, scratch off or wear off. And you still enjoy these proven Beetle plastic advantages: hard, lustrous surfaces; resistance to detergents, oils and grease; good electrical properties; heat resistance; unlimited range of color possibilities.

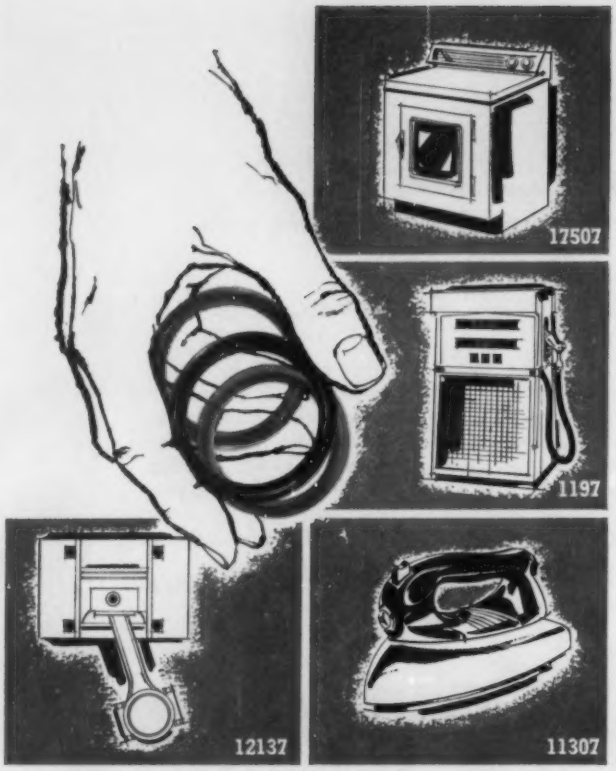
P.S. Now is the time for all good BUSINESS MACHINE MANUFACTURERS to look into BEETLE for lettered decoration.



AMERICAN CYANAMID COMPANY CYANAMID PLASTICS AND RESINS DIVISION

Wallingford, Connecticut. Offices in: Boston • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Detroit • Los Angeles • Minneapolis • New York • Oakland • Philadelphia • St. Louis • Seattle • In Canada: CYANAMID OF CANADA LIMITED, Montreal • Toronto

CIRCLE 61 ON READER SERVICE CARD 61



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The next step towards perfect sealing in your product may start with one of these 4 Precision "O" Ring Compounds. Use-proved, they are giving reliable service in hundreds of products.

17507 Industrial Quality Viton, sealing to 550°F in air and oils. Long life service under acids, alkalies, aromatic and chlorinated solvents.

11307 Industrial Silicone for service range from —75° to 450°F in lubricating, hydraulic and pneumatic systems.

1197 Compound for service in fuel oil, gasoline, fuel gas, anhydrous ammonia and lubricating oils. —45° to 250°F.

12137 Polyacrylate service range from — 40° to 350°F in severe service with hypoid gear, and transmission lubricants, both "O" Ring and Lip Seals.

Put maximum reliability in your product by coming to Precision for the **right** "O" ring, made **right,** from the **right** compound.

Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialist

Box 431, Oakridge Drive, Dayton 17, Ohio Canadian plant at: Ste. Thérèse de Blainville, Québec

each preset count is completed. Transistor-equipped with 2 to 6 in-plane displays. Priced at $710 to $750 with delivery in 3 to 6 wk. **Robotomics Inc, 2422 E Indian School Rd, Phoenix, Ariz.**

Circle 324 on Reader Service Card

Force measuring transducer . . .

is available in seven models with full load ratings of 1000, 2000, 5000, 10,000, 20,000, 50,000 and 100,000 lb (units rated as low as 100 lb or high as 500,000 lb supplied on request). Sensing function is performed by resistance wire, high-temperature, weldable strain gage in a bridge configuration within a ring. Unit can be overloaded as much as 50% without destroying calibration and can be used without damage from —300 to 750 F. Stability reportedly is maintained even where there is a steep temperature gradient across the transducer. Bridge impedance is 120 ohm; recommended input voltage, 10 v with max of 15 v allowable; and nominal output voltage, 25 mv full scale with 10 v input. Linearity and hysteresis are both within 0.2% and total errors from all causes is less than ±2% over temperature range of —65 to 600 F. Contains no organic materials and can be supplied sealed. **Microdot Inc, 220 Pasadena Ave, South Pasadena, Calif.**

Circle 325 on Reader Service Card

Aluminum cable clamp . . .

has neoprene cushion that holds cord or tubing with a non-sliding grip, preventing any strain on connections. Cutting and scraping of cord insulation also is minimized by the flame- and oil-resistant cushion. Available for ⅛- to 2-in. cable in ⅛-in. increments. **Richco Plastic Co, Dept PE-1, 3722 W North Ave, Chicago 47.**

Circle 326 on Reader Service Card

Pressure transducers . . .

available as gage-, absolute- and differential-pressure measuring units, provide nominal full-scale output of 200 mv with an accuracy of 2½% over entire temperature range from —65 to 1000 F. At room temperature, accuracy is ½% and over any 250° span, 1%. Full-scale measurements range from 0.6 to 5000 psi. To provide infinite resolution, position of a pressure-sensitive bellows or diaphragm is transmitted to the core of a differential transformer. Thus, information is passed in the form of a varying magnetic field rather than through mechanical linkage, eliminating need for moving seals. Electric portion consists of an ac regulator and demodulator and contains an oscillator power supply. The all-solid state circuit makes output inde-

continued on page page 64

Fractional Horsepower Motors

Lamb Thinking on Universal Motors for a unique actuator application

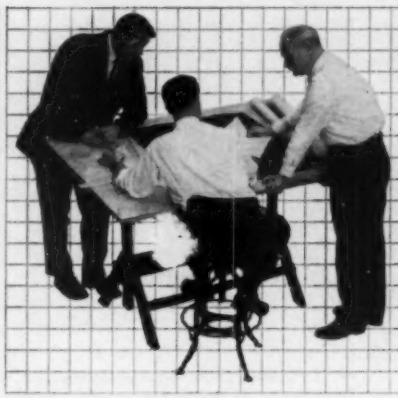
Here's what Lamb Electric designed into these motors:

In order to obtain the required speed and torques and retain the most economical and smallest package, a combination worm and spur gear reduction was used. Also, because of the peculiar space limitations in the application, special design considerations had to be given to the gear ratios and mechanical layout of the package.

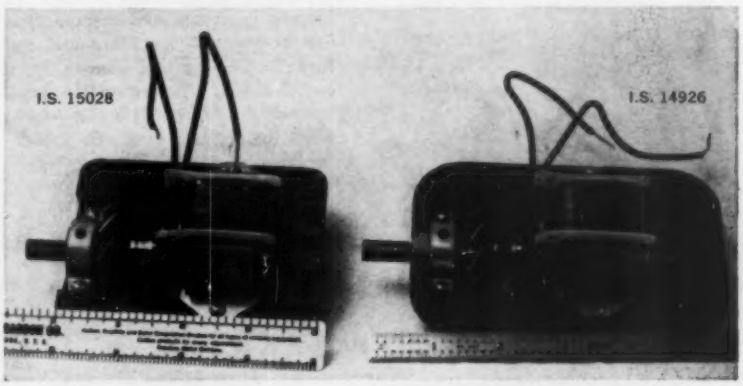
In the initial stages of the design a motor was provided which met the specified speed and torque requirements, however it was soon discovered that this design overheated rapidly. Analysis of the first prototype tests showed that the load cycle had a particularly high torque peak for a very short duration. The motor was designed to supply this amount of torque near its stalled speed. It was found that by taking advantage of the accelerating rate and starting torque of a universal motor, the motor accelerated quickly enough to provide sufficient inertial energy to complete the duty cycle. This enabled the engineers to redesign for a lower peak horsepower output and obtain reasonable operating temperatures, thus producing the minimum size package consistent with the torque and temperature requirements.

The application was such that severe shock loading was encountered at a certain point in the duty cycle. In order to make mechanical construction that would withstand this service, ductile iron castings were furnished and special consideration had to be given to the overhung moment of the motor-gear unit to insure against damage due to vibration. Special bearings had to be used in this service because Brinnelling would occur on normal ball bearings under the severe service encountered. Lubrication is generally a problem under this short duty cycle, therefore, special consideration had to be given to insure that the lubricant protected the wearing surfaces at all times.

This is just a short example of Lamb at work . . . if you have a motor problem, let us help you with it. This is our business. Write: Lamb Electric, Kent, Ohio, and we'll have a Lamb District Engineer call on you to open preliminary discussion of your problem.



THE LATEST DESIGN NEWS ON FHP MOTORS FROM LAMB ELECTRIC



New Lamb motors represent advancements in small universal motor design

New design combines high quality and long life with relatively low manufacturing costs

Initially, the I.S. 15028 and companion motor I.S. 14926 were designed for powering rug agitators on a well-known line of canister-type vacuum cleaners. Now, many future appliance applications have been visualized. The range of ratings possible with this design (as high as 1/10 H.P. at 12000 RPM or ⅛ H.P. at 15000 RPM) makes this motor ideally suited for many motor powered domestic applications.

Some of the novel features of this motor project were:

The housing is a one-piece simple phenolic molding. It is designed in a half shell form in such a way that the motor bearings and other components can be held in accurate relationship with an unmachined housing.

The half shell housing of the motor is designed to mate with a corresponding opening on the customer's device to complete the motor enclosure. When a free standing motor is desired, this upper enclosure can be a simple stamping.

The I.S. 15028 motor was designed with a sleeve and a ball bearing. However, on other versions of this motor, either sleeve or ball bearings or a combination can be used at only a low tooling expense through use of easily interchanged inserts in the housing mold cavity.

The sleeve bearing as used in this design takes full advantage of the economics possible with the half shell motor design. The full-spherical shaped self-aligning type of sintered bearing is mounted directly in a semi-spherical recess in the housing. A spring clip presses against the top of the bearing to secure it in place while at the same time permitting self-alignment movement. Life-time lubrication is provided by an oil soaked felt strip located beneath the bearing. There are other features worth noting in this unique design problem. For further particulars, write to Lamb Electric Co., Kent, Ohio.

pendent of line voltage and temperature variations. Its output is used to excite the differential transformer, and in addition to correcting temperature and line voltage variations, circuit corrects for changes in cable impedance and for nonlinearity of the pressure element. Full-scale linearity is ±0.5%. Resonant frequency varies from 200 to 2000 cps, depending on pressure range. Input power is 110 v ac at 60 or 400 c and 28 v dc. **Consolidated Controls Corp, Bethel, Conn.**

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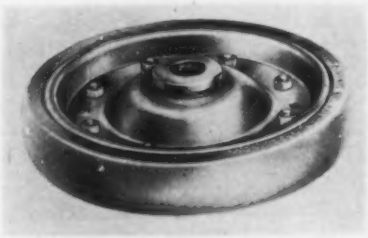

Steel disk wheels . . .

have 6- or 8-in. replaceable polyurethane tires that reportedly roll easily under heaviest or bulkiest loads. Compared with rubber wheels, rolling resistance is said to be negligible so that inertia of a 700-lb load can be overcome with light push. Polyurethane tires also are corrosion-resistant and do not mark or stain light colored asphalt or vinyl surfaces. Load capacity of 6-in. tire is 500 lb; 8-in. tire, 700 lb. **Jarvis & Jarvis Div, United Service Equipment Co Inc, Palmer, Mass.**

Circle 328 on Reader Service Card

Teflon-insulated feedthrough terminal . . .

is suitable for installations requiring conductor paths through motor housings, metal potentiometer cases or other equipment in which temperature, vibration and space savings are considerations. Teflon body, which is press-fitted into a prepared hole in the mounting surface, withstands temperatures from —85 to 392 F and overcomes cracking or breakup caused by vibration and shock. Terminal is 0.343 in. high; mounting bushing diameter is 0.150 in.; and overall-diameter of Teflon body is 0.172 in. Hole-through stud with turret permits wiring to be run through and wrap-soldered. Hole-through is 0.031 in. dia, and stud OD is 0.047 in. **Sealectro Corp, 610 Fayette Ave, Mamaroneck, NY.**

Circle 329 on Reader Service Card

Silicon strain gage . . .

measures only 0.05 in. in active length, has a gage factor of 110 and resistance of 120 ohm. Other models range in lengths to 0.5 in. in resistances from 120 to 1000 ohm and gage factors from 120 to —100. Temperature range is from —320 to 650 F. Available with or without adhesive backings at $80 to $98 for a package of four. **Micro Systems Inc, 319 Agostino Rd, San Gabriel, Calif.**

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Rubber-like compound . . .

for molding (or making molds for) experimental parts, is a room-temperature curing mixture of two liquids. Available in two forms: putty-like substance that can be applied to a vertical surface without running or sagging and a liquid type that can be poured. Both are said to have high tensile, tear and abrasion resistance and also good adhesion to iron, steel, aluminum and other metals as well as to wood, natural and synthetic rubber, canvas, glass, some plastics, etc. Once cured, they reportedly have considerable resiliency and little or no tendency to "cold flow" or change shape under pressure. Supplied in 1- and 12-lb containers. Trial kit, containing 1 lb each of the two available forms, curing agent for each material, and instructions, is priced at $6.70. **Devcon Corp, Danvers, Mass.**

Circle 331 on Reader Service Card

Drawing pen set . . .

is complete with pen, rubber nib wrench and six interchangeable drawing point sections in line widths from superfine to extra broad. Each section has a precision stylus guide. Filled directly from ink bottle, pen holds extra large supply of ink and has transparent window that indicates time for refill. Permanent built-in refill cap prevents loss. Plunger stops automatically, making it impossible to overfill. Set is packed in vinyl, two button flap carrying case with separate compartments for each unit. Suggested retail price, $12.95. **Alvin & Co Inc, 611 Palisado Ave, Windsor, Conn.**

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Graph rubber stamp kit . . .

records graph material entailed in engineering notebooks, reports, etc. without need for bulky sheets of graph paper. Stamps a clear graph pattern wherever needed. Kit comprises three graph patterns: (1) 100 blocks per sq in. for plotting wave form patterns on cathode ray oscilloscopes, etc.; (2) ¼-in. grid pattern, 16 blocks per sq in. for plotting in larger scale than former; and (3) polar coordinate graph stamp, 3 in. dia circle with major subdivisions at 15 deg and small markings at each 5 deg. A large 3¼ x 6¼-in. ink stamp pad is included. Priced at $10. **Edmund Scientific Co, Barrington 54, NJ.**

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REPRINTS

The following special reports are available as long as the supply lasts—from Reader Service Dept., Product Engineering, 330 W 42nd St, New York 36. Please enclose remittance; we pay postage.

Rolling-element Bearings $2
Ball, roller and thrust bearings—their selection, test and analysis of their failures, 64 p.

Design with Steel $2
Latest design data for a wide range of steels and alloys for high strength and high temperautre, 64 p.

The New Mathematics $2
Combined reprint of 18 articles with coverage in depth of the latest math tools of systems engineering, 64 p.

Wk² and Motor Selection $2
How to calculate rotational inertia and what it means in duty-cycle selection of motors and drives, 64 p.

Engineering Models $2
Working prototypes as well as 3-D "sketches"; here's how to design and make them, 64 p.

Shortcuts for Longhand Computation $2
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Patent Problems $1.50
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Combined reprint of 5 steps to faster reading; 8 steps to better writing; 7 steps to better reporting, 24 p.

Why Don't They R & D? $1
Here are 200 ideas for new inventions not now on the market, 64 p.

9 Lectures on Mechanisms $1
How linkages and springs may be designed to balance loads, transmit forces, feed parts, 24 p.

Manual of Reliability 50¢
How to design for reliability, human factors, statistical tools; implementing the programs, 32 p.

the LEAD newsletter

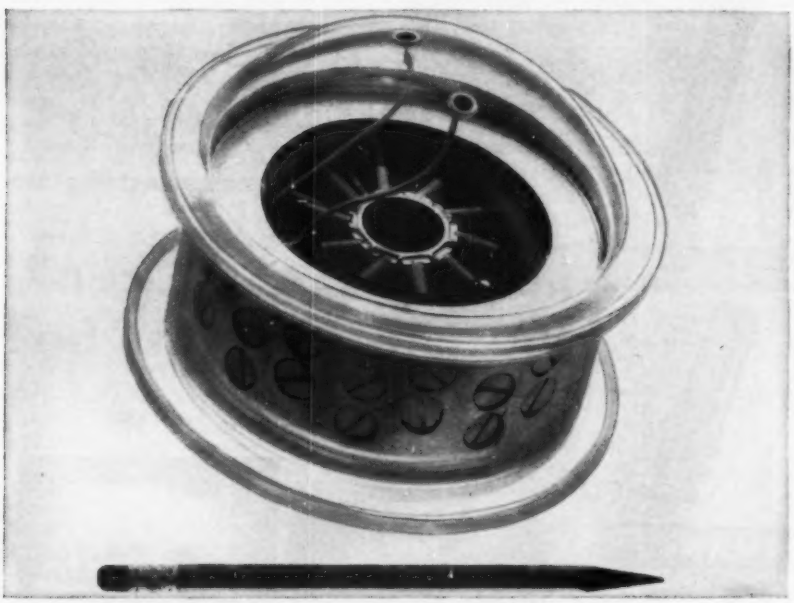
Vol. 3 No. 3

Space-vehicle uses for lead have triggered a vigorous chain reaction among product design engineers with an eye to more down-to-earth markets.

Envisioned – or already demonstrated to be practical – are gas- and oil-fired home heating units that generate their own electricity to provide power for fans, blowers, and pumps; continuous charging of automobile batteries without a generator; power for many uses remote from utility lines, or produced from waste heat sources.

Lightweight Power Source

First practical demonstration of direct conversion of atomic reaction heat to electric current was provided by the SNAP III power package (illustrated), a device introduced in 1959 to power communications equipment in satellites and space vehicles. Weighing just 5 pounds, it produced 10,000 watt hours over 280 days. If The Atlas "talking satellite," orbited December 1958, had such equipment, it could have sent continuous signals for several months.



Thermoelectricity via Lead Telluride

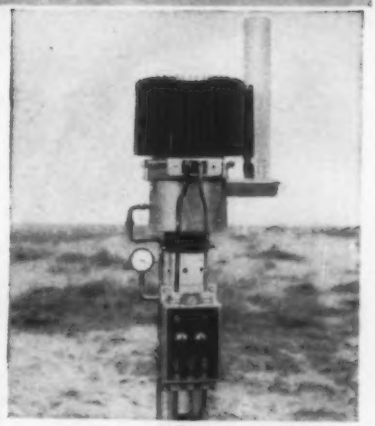
Basic to these advances is thermoelectricity, a phenomenon which manifests itself in two opposite ways. The first occurs when current is passed through a thermoelectric material: one end of the material gets hot, the other cold. This is the "heat pump" effect, the principle of thermoelectric refrigeration. But if heat is applied to one end of such material, power is generated.

The efficiency of a material in these uses – what solid state physicists call its "figure of merit" – depends on the temperature range of application. In the temperature range most useful for power generation (350° to 1250° F.) the most effective substance yet discovered is *lead* telluride.

Protects Gas Mains and Truckmen

A thermoelectric generating unit using lead telluride is being used to power cathodic protection systems on gas mains. Burning gas from the mains supplies the heat. Tests show that electricity from lead telluride is actually cheaper than from power lines.

Another use of lead telluride elements is in a truck cab heater now available. Fueled by L-P gas, it enables drivers to sleep in heated cabs without danger of carbon monoxide fumes from running motors. Such elements are also used in detector heads of a monitored fire protection system, allowing more rugged, dependable, and efficient installations.



Cathodic Protection Service

Applications are Growing

Lead telluride generators in an actual power package have conversion efficiencies around 7 to 9%, with 12% efficiency predicted by the Dept. of Commerce for 1962. While not enough to compete with big land-based utilities, it's ample to carve out a real commercial market for these devices as auxiliary power and portable power packages. Several large appliance makers are among those now researching additional applications.

One company predicts that, with volume production, cost of thermoelectric power can be cut below $1 a watt. Portable power supplies in the 5 to 10 kilowatt range are being developed right now. Units generating 100 to 1000 kilowatts are considered feasible by 1965. Trickle charging systems for lead acid batteries are one particularly attractive possibility that should make a battery system more competitive, create many new applications.

Lead is keeping pace with new technology in many fields. For technical information and help in applying lead to your own products and problems, simply write: Office of Technical Information, Lead Industries Association, 292 Madison Ave., New York 17, N. Y.

4480

LOOK AHEAD WITH LEAD

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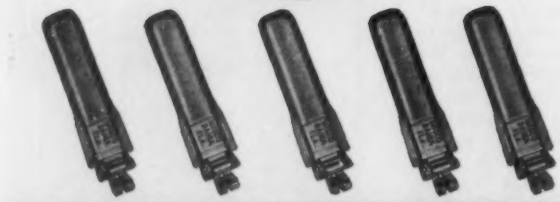
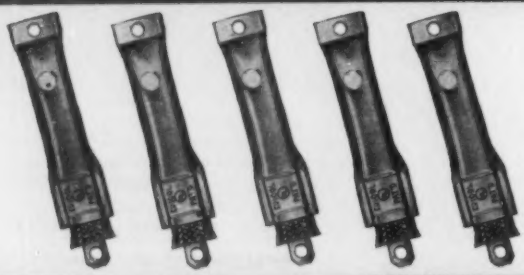
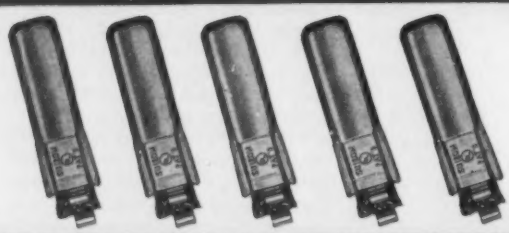
MIGHTY MITE
MOTOR PROTECTORS



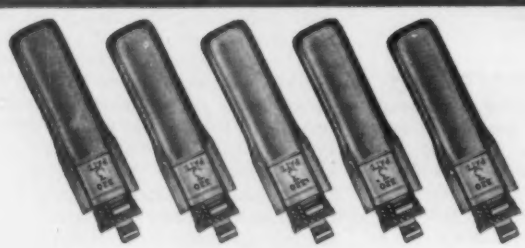
STANDARD DESIGNS



UNIFORM QUALITY



TIME PROVEN PERFORMANCE



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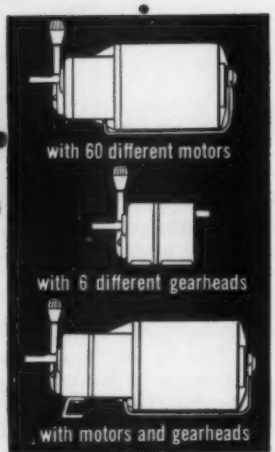

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DESIGN LITERATURE

Industrialism and Industrial Man

KERR, DUNLOP, HARBISON AND MYERS. Harvard University Press, Cambridge 38, Mass. 6¼ x 9½, 331 pp. $6.

Since engineers are one of the unique products of the industrialization process, a book about the social systems which they help to create should be as personally interesting as an evaluation of how one's own industry is organized and functions. And there is no doubt that this book should help the engineer to understand the sources of some of the seemingly meaningless limitations and frustrations imposed on him by the management of his company, the character of his industry's market and the leadership of his society.

But the engineer and all recognition of his works have been left out of this story. It may be argued that this book is primarily concerned with the problems of the new countries, those just beginning the processes of industrialization. Yet we hear regularly of the desperate shortage of scientifically and technically trained people in these new nations. We read of the decisive roles such specialists play when they graduate from our schools and head home to begin their arduous lifeworks.

Apparently, the economists who wrote this book are generally ignorant of the technological basis of the labor-management relations in which they specialize. Their particular kind of ignorance has been accurately described by C P Snow in his essay, "The Two Cultures" (*PE*—Oct 10 '60, p 88).

It's a pity, because despite their limitations, the authors have done the best job yet of explaining why nations industrialize and how it changes their peoples and governments. The authors analyze the inevitable division of societies into the "managers" and the "managed". In fact the authors make it abundantly clear that engineers, professionalism and all, are among the latter on all significant counts. —JK

Gas And Air Compression Machinery

LYMAN F SCHEEL. McGraw-Hill Book Co, Inc, 330 W 42 St, NY 36. 9¼ x 6, 338 pp. $12.00.

The book covers three areas—a mathematical treatment of the static and kinematic behavior of gases; discussion of the various types of machinery used in the movement of gas, including reciprocating, turbo, rotary, and ejector types; and prime movers used for gas machinery, their installation, accessories, maintenance, and operational details. The book is primarily based on heavy industrial reciprocating compressors and centrifugals, and has comparatively brief coverage of axial and screw-lobe types. With the book, you can almost design a complete reciprocating-type compressed air system, including entire compressor, piping, controls and accessories. Authors introduce new concepts in piston compression, with new equations for calculating volumetric efficiency.

Other Books of Interest

The Atom and Its Nucleus

George Gamow. Prentice-Hall Inc, Englewood Cliffs, NJ. 5½ x 8, 153 pp. Paperback, $1.95.

A Summary of Comparative Properties of Air-melted and Vacuum-melted Steels and Superalloys

PB 151085, D C Ludwigson, F R Morral. Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8½ x 11, 143 pp. $2.75.

Maintainability Handbook for Electronic Equipment Design to Navtradevcen 330-1 Design for Maintainability

PB 161025. McKendry, Grant, Corso, Brubaker. Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8½ x 11, 387 pp. $5.

An Introduction to Linear Statistical Models, Vol. 1

Franklin A Graybill. McGraw-Hill Co Inc, 330 W 42 St, NY 36. 6 x 9¼, 463 pp. $12.50.

Industrial Purchasing

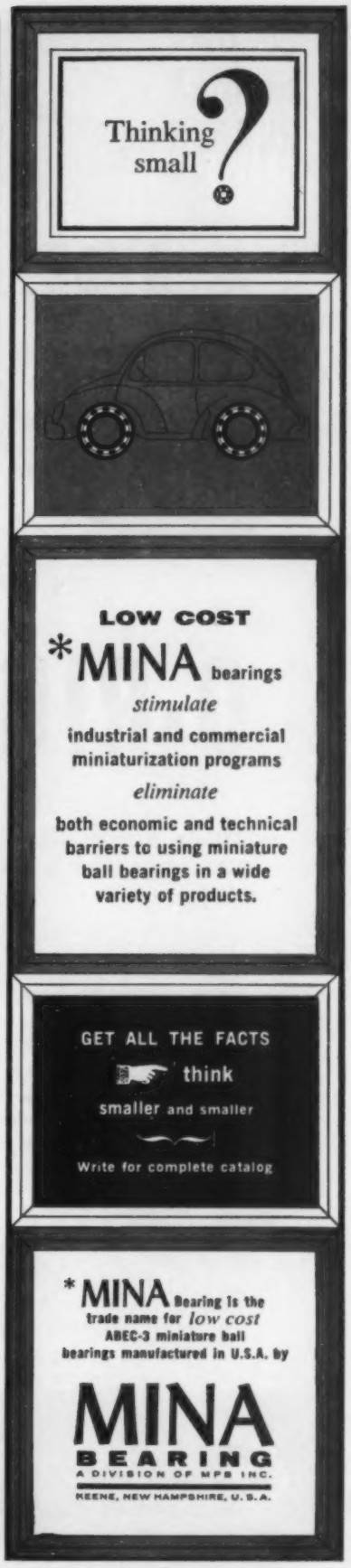
J H Westing, I V Fine. John Wiley & Sons Inc, 440 Park Ave South, NY 16. 6 x 9, 534 pp. $9.50.

ABSTRACTS FROM THE LITERATURE

Lubricants for High-temperature Applications

As part of a program of developing lubricants and lubrication techniques for high-speed ball bearings operating over the temperature range from room temperature to 1200 F, candidate lubricants were screened in a high-temperature, high-speed, rolling-disk apparatus. Finely divided, inorganic solids suspended in a gas

continued on page 69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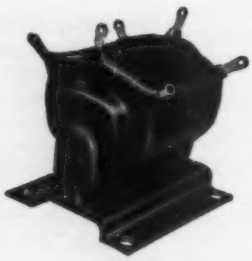

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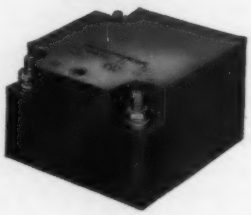

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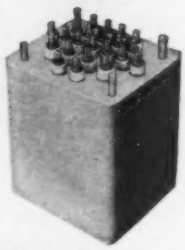

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SAA3502/1058

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In Canada: Acme Electric Corp. Ltd., 50 Northline Rd., Toronto, Ontario

Acme ACME Electric

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carrier were the principal lubricants selected for the screening evaluations. In order to choose a small number of the most promising compounds from this large group of materials for evaluation, selection criteria were established and applied. These criteria included some of the physical properties which have traditionally been considered important lubricant characteristics. In addition, thermodynamic calculations were used to judge the probability of chemical reaction between prospective lubricants and the substrate materials.

"The Use of Free-Energy Relationships in the Selection of Lubricants for High-Temperature Applications," F. K. Orcutt, H. H. Krause, C. M. Allen, Battelle Memorial Institute. American Society of Mechanical Engineers, 61-LUBS-14, 29 W 39th St, NY 18.

Classification of Vinyl Resins

Described is a practical method for determining processing behavior of polyvinylchloride, polyvinylacetate and polyvinychloride-acetate copolymers.

"Improved Classification of Vinyl Resins," by Robert Braddicks Jr and Thomas Van Deren, Kentile Inc, SPE Journal, Oct 1960, Society of Plastic Engineers, 65 Prospect St, Stamford, Conn.

Techniques of Dynamic Display

The article describes a wide variety of special techniques. Although these cannot be classified either as pure cathode ray tube techniques or optical techniques they are just as important. Some of the most promising developments in the display field are discussed here. They include: TV pickups, character displays, drum storage systems, and matrix cells.

"Techniques of Dynamic Display," by Richard A. Barker, Lockheed Electronics Co, Control Engineering, June 1960, 330 W 42nd St, NY 36.

Painting Welds

As the welding of steel structures comes into more and more prominence, so does the problem of getting the best possible corrosion protection for those welds. Frequently the paint covering a welded area will fail while the remainder of the paint is still in excellent condition. Because of the importance of the problem and the dearth of practical information on the subject, a study of this problem was undertaken three years ago by the Steel Structures Painting Council; this

continued on page 71

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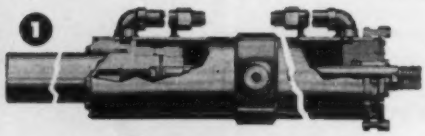
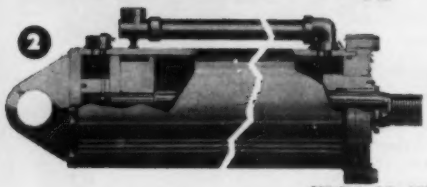


BUCKET CYLINDERS— 6-inch bore, 26-inch stroke, double-ended, double-acting



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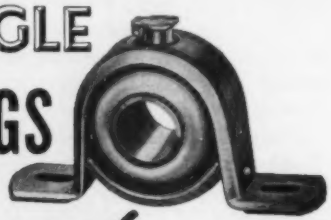

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paper is a report of the research committee on the subject.

"Painting of Welds," by John D. Keane, research director, and Joseph Bigos, head, Organic Coating Section, Corrosion, Dec 1960, National Assn of Corrosion Engineers, 1061 M & M Bldg. Houston 2, Texas.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

CLAMPS, COUPLINGS AND JOINTS—Catalog 803, 44 pp. Covers band, hose and pipe repair clamps; V-band couplings and flanges; pipe couplings; pipe and tube joints, etc, supplying photographs, burst pressure curves, dimension drawings and tabulated specifications. Marman Div, Aeroquip Corp, 11214 Exposition Blvd, Los Angeles 64.

Circle 350 on Reader Service Card

WORM GEAR SPEED REDUCERS—Catalog 571B, 16 pp. Carries hp ratings and dimensions of mounting type units with 1⅛- to 3-in. centers. Gear assembly arrangements and outline drawings are included. Crofts USA Inc, 2542 W Peterson Ave, Chicago 45.

Circle 351 on Reader Service Card

VARIABLE SPEED SHEAVES—Bulletin 25103, 16 pp. Describes and illustrates nonfreezing, nonsticking sheaves rated from 2 to 20 hp, as well as companion pulleys and sheaves, variable speed belts, motion control motor bases, etc. Speeds, dimensions and prices are tabulated. T B Wood's Sons Co, Chambersburg, Penna.

Circle 352 on Reader Service Card

VINYL-ALUMINUM LAMINATE—Brochure, 20 pp. Discusses performance and uses for the material and contains a sample as well as chips of each of 30 vinyl color-pattern combinations. Aluminum Co. of America, 720 Alcoa Bldg, Pittsburgh 19.

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CHAIN DRIVES—Bulletin 611P, 12 pp. Includes new ARSCM hp ratings for both roller and steel chains. Other data for selecting proper chain drive covers chain sizes, sprocket sizes, center distances, chain lengths and sprocket ranges. Chain Belt Co, Sales Promotion Dept, Milwaukee 1.

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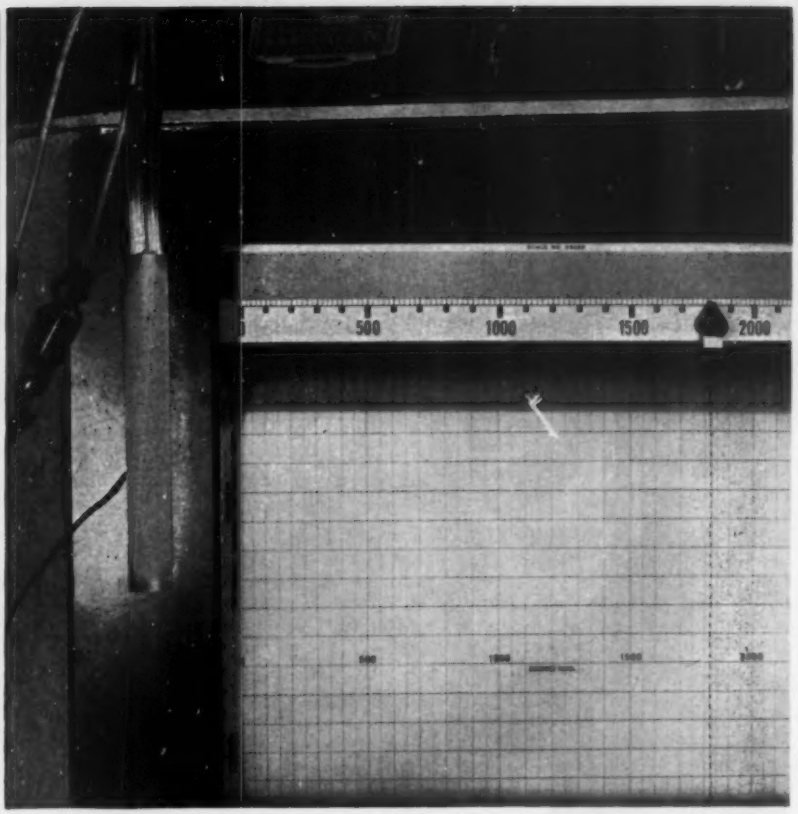
POUR-IN-PLACE URETHANES—Booklet, 12 pp. Lists physical properties of typical formulations and discusses and illustrates such applications as low temperature insulation, building structures, pot-

continued on page 72



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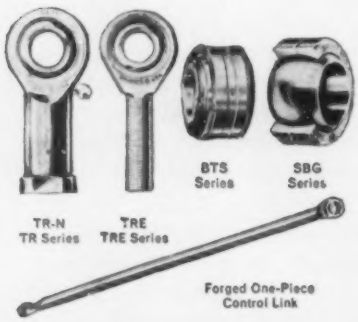

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DESIGN LITERATURE

ting, cushioning and packaging. Plastics Div, Nopco Chemical Co, 175 Schuyler Ave, North Arlington, NJ.
Circle 355 on Reader Service Card

CONTROL VALVES—Bulletin LB-4, 16 pp. Details construction, operation and specifications of single-seated, split-body valves. Includes schematics, cutaways and valve sizing formulas. Conoflow Corp, 2100 Arch St, Philadelphia 3.
Circle 356 on Reader Service Card

RHENIUM AND RHENIUM ALLOYS—Brochure, 12 pp. Reviews properties and advantages of rhenium, rhenium-molybdenum and rhenium-tungsten alloys, noting their application in the electronics, nuclear, missile, aerospace and electrical fields. Performance curves and weight charts are included, Rhenium Div, Chase Brass & Copper Co, Waterbury, Conn.
Circle 357 on Reader Service Card

MOLDED PACKINGS—Catalog MP-361, 8 pp. Products covered include V-packings, U-rings, piston rings, V-rings, U-cups, O-rings, etc. Tables list: specifications; various compounds in which each packing is furnished; types of packing recommended for specific machinery, etc. Greene, Tweed & Co, North Wales, Penna.
Circle 358 on Reader Service Card

SINGLE-TURN WIREWOUND POTENTIOMETERS—Folder, 6 pp. Spells out performance features and tabulates electrical and mechanical specifications of linear, non-linear and sine-cosine potentiometers. Included are photos, cutaways and outline drawings. Fairchild Controls Corp, 225 Park Ave, Hicksville, LI, NY.
Circle 359 on Reader Service Card

VARIABLE TRANSFORMERS—Catalog section 1, 40 pp. Contains electrical ratings and other specifications; application data and performance characteristics of bench or panel mounting, cased and uncased units ranging from 0.165 kva-1.25 amp to 7 kva-25 amp. Among illustrations are charts, graphs, circuit arrangement diagrams and dimension drawings. Standard Electrical Products Co, 2240 E Third St, Dayton, Ohio.
Circle 360 on Reader Service Card

56-FRAME AC MOTORS—Bulletin L-3313A, 6 pp. Presents selection data, specifications, mounting arrangements, performance curves and principal dimensions of units rated from ¼ to 2 hp. Also illustrates wide variety of special designs. Kingston-Conley Inc, Sub of Howell Electric Motors Co, Plainfield, NJ.
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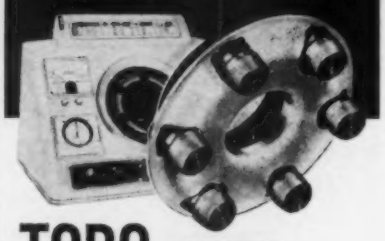
continued on page 75

another
NEW IDEA



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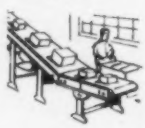

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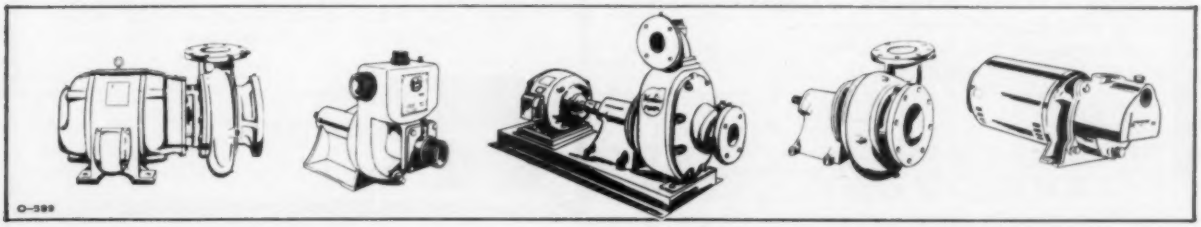

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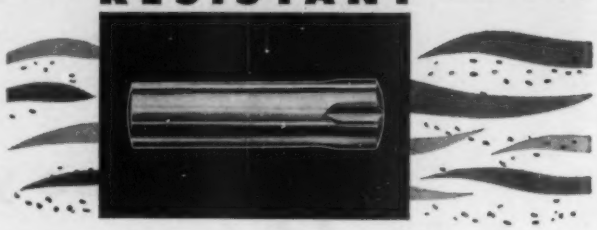

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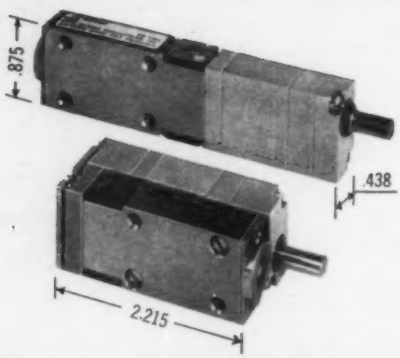

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CIRCLE 92 ON READER SERVICE CARD

MEASURING INSTRUMENTS—Bulletin 321.11, 12 pp. Outlines ranges and other performance data on gages for indicating draft, pressure, differential gas pressure and temperature and pneumatic impulses from transmitters. Dimension drawings and response curves are included. Republic Flow Meters Co, 2240 Diversey Pkwy, Chicago 47.

Circle 362 on Reader Service Card

NICKEL ALLOY COATING—Booklet 561, 12 pp. Reviews process for chemically depositing a uniform, hard, corrosion- and abrasion-resistant nickel alloy coating on iron, copper, aluminum, titanium, and their alloys. Traces coating's properties and performance and tabulates commodities and test conditions under which it is considered suitable. Kanigen Div, General American Transportation Corp, 135 S LaSalle St, Chicago 90.

Circle 363 on Reader Service Card

SHEAR PIN SPROCKETS—Catalog CD-104-A, 4 pp. Supplies specifications, photos and outline drawings of stock sprockets with shear pin hubs and split taper bushings. Browning Mfg Co, Maysville, Ky.

Circle 364 on Reader Service Card

SPRING PINS—Bulletin 2670, 8 pp. Describes and illustrates 16 different applications and suggests others. Data includes standard stock sizes by material; recommended pin diameters for various shaft sizes; taper pin size equivalents; spring pin weights by size; insertion and removal forces in steel assemblies, etc. Standard Pressed Steel Co, Box 545, Jenkintown, Penna.

Circle 365 on Reader Service Card

AIR VALVES—Bulletin 0611-B1, 4 pp. Design features and performance data are outlined for three high-speed, pilot-operated models with working capacities from 15 to 150 psi. Operation and control of the main valve is discussed and diagrammed. Hannifin Co, Dept 126, 501 S Wolf Rd, Des Plaines, Ill.

Circle 366 on Reader Service Card

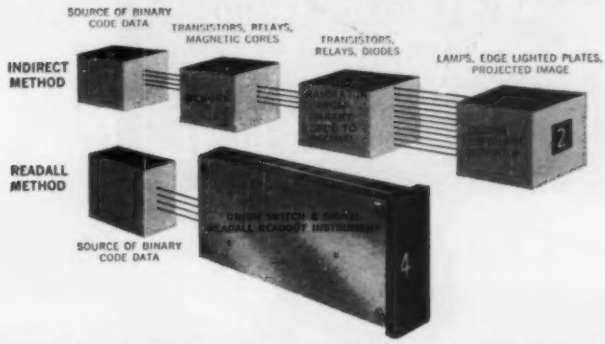
BERYLLIUM COPPER ALLOYS—Four data sheets, 4 pp each. Show physical and mechanical properties and provide data on heat treating, forming, joining and plating of beryllium copper. Brush Beryllium Co, 5209 Euclid Ave, Cleveland 3.

Circle 367 on Reader Service Card

POTENTIOMETERS, TURNS-COUNTING DIALS—Brochure BED-A195, 4 pp. Covers nine potentiometer series and six turns-counting dial series, providing standard resistances and tolerances, temperature ranges, power ratings,

continued on page 77

READALL READOUT NEWS from Union Switch & Signal



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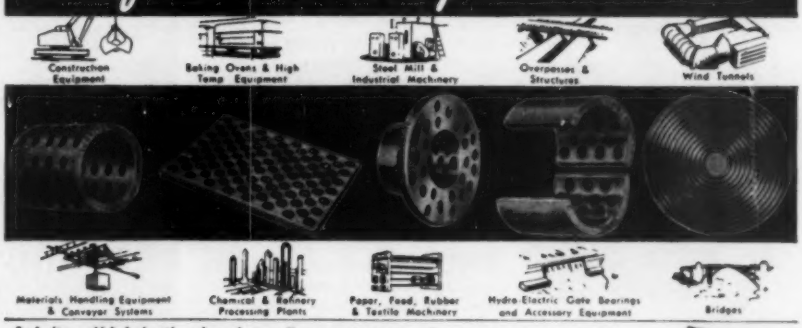
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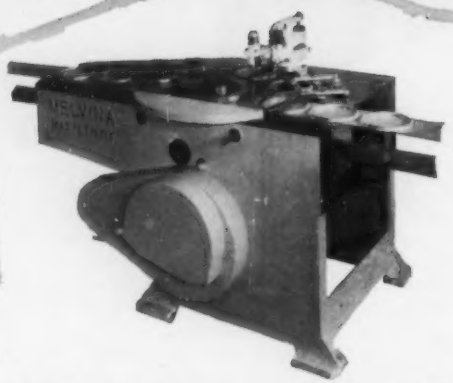

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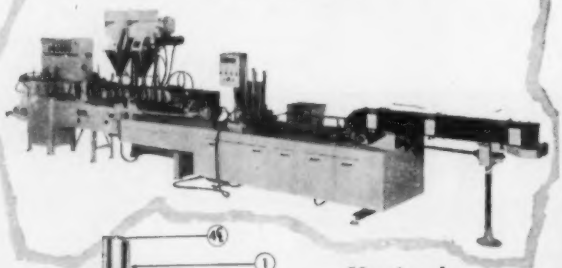

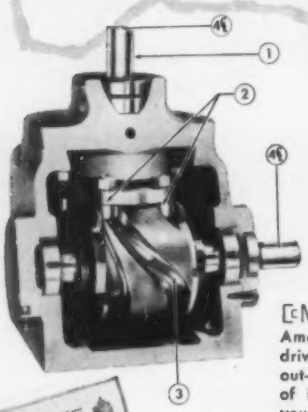

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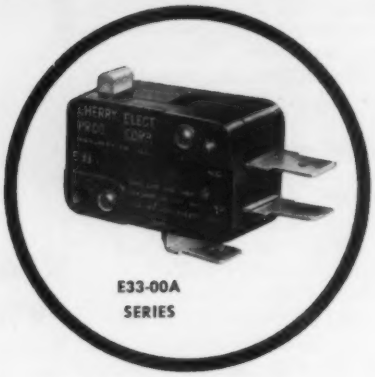

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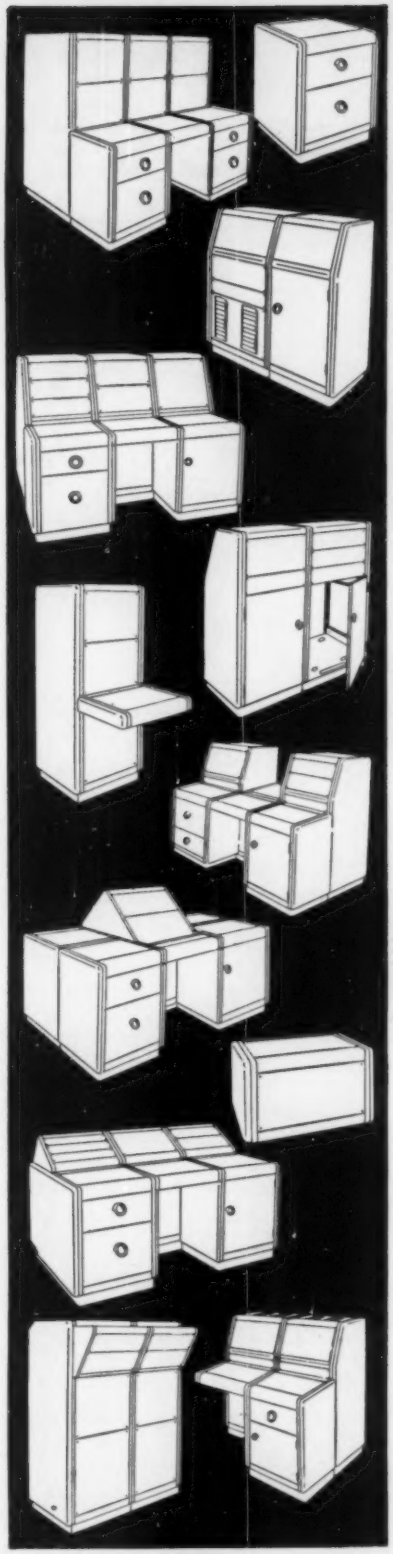

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Issue of August 14, 1961
PRODUCT ENGINEERING
Card expires October 13, 1961

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

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PRODUCT ENGINEERING
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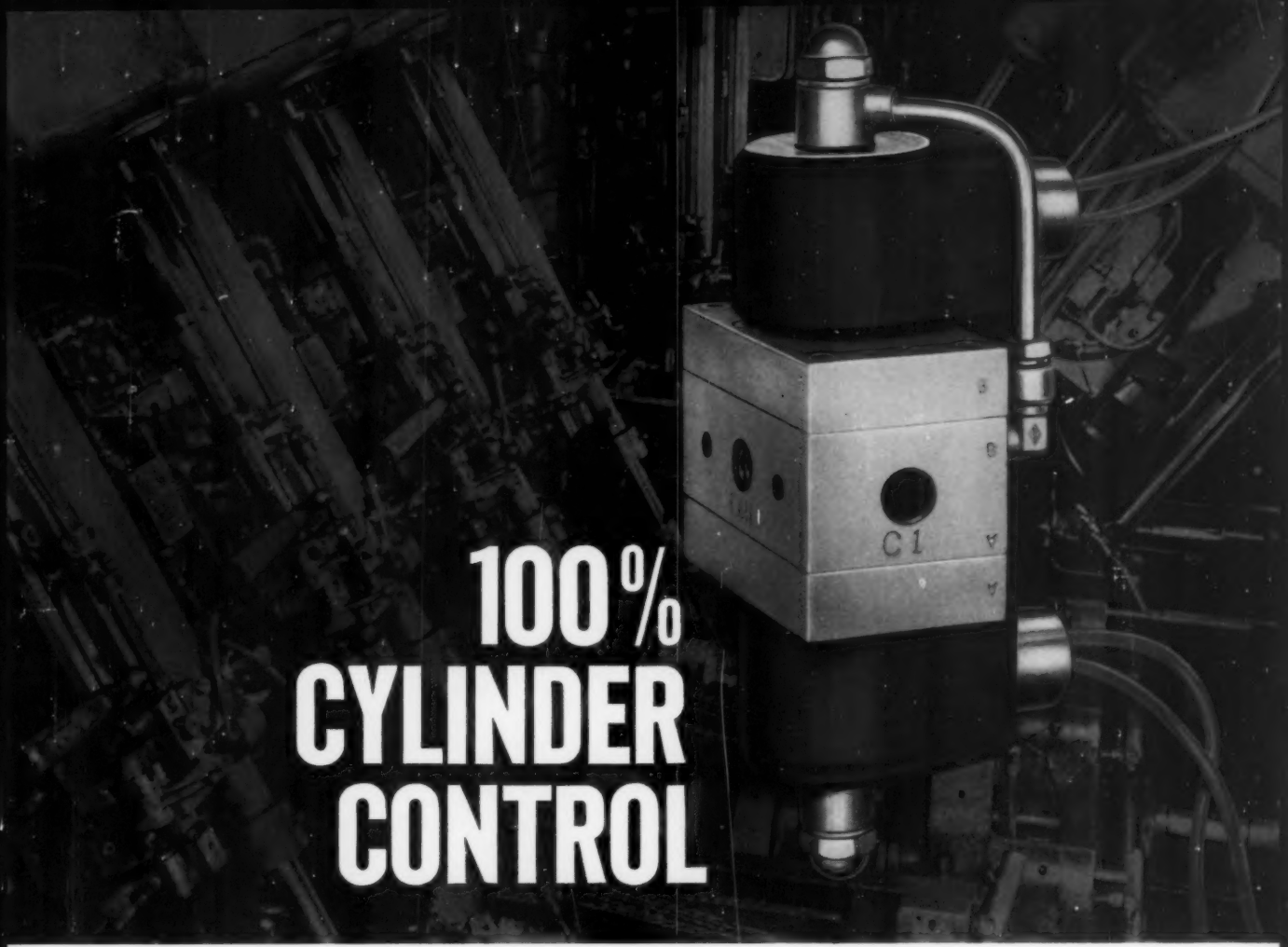
NEW YORK 36, N. Y.

25th FLOOR



100% CYLINDER CONTROL

DEAD-TIGHT SEATING OF ASCO 4-WAY SOLENOID VALVE PREVENTS PISTON DRIFT ...PERMITS PRECISION INCHING

3-POSITION, 4-WAY DESIGN

POPPET-TYPE SEATING— CANNOT STICK OR LEAK

INSTANTANEOUS OPERATION

EXPLOSION-PROOF ENCLOSURE AVAILABLE

PRESSURES UP TO 250 PSI ON AIR, WATER OR OIL

RUGGED BRASS BAR STOCK

2 SOLENOID CORES AND 4 DIAPHRAGMS ARE ONLY MOVING PARTS

Positive control of the cylinder piston is inherent in the design of this ASCO Bulletin 8347 valve. Leakage of air or liquid is made impossible, so that whenever both solenoids are de-energized, the valve assumes a center position and all orifices are blocked, locking cylinder piston in position. Dead-tight (poppet-type) valve seating permits precision inching of the piston, as well as absolute control of any length of stroke, with instantaneous stopping and not a trace of drift.

The utter simplicity of design and rugged construction assure many millions of trouble-free operations. You can choose the 8347 in either the ¼" or the ⅜" pipe size for pressures to 250 psi, and you can mount it in any position. It is available from stock for immediate delivery, as are other ASCO solenoid valves.

Write for Bulletin 8347, providing complete descriptive information on this new, reliable 4-way.

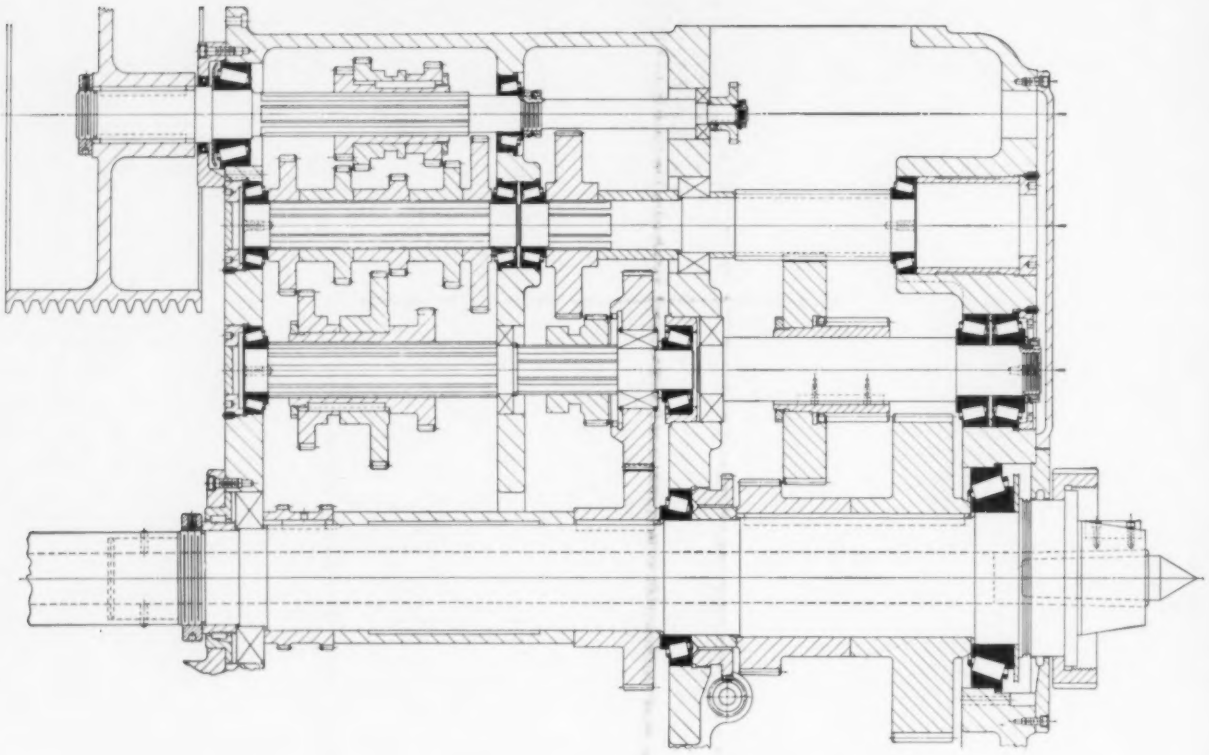
ASCO Valves

ASCO

DEPENDABLE CONTROL BY Automatic Switch Co. 54G HANOVER RD., FLORHAM PARK, N. J. • FRONTIER 7-4600 • *AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL*

CIRCLE 174 ON READER SERVICE CARD

How world's largest tracer lathe assures precision



Engineers of The American Tool Works Co. design maintenance of high precision right into their new Maxi-Swing Tracer Lathe with 16 Timken® tapered roller bearings on the nose and center of the spindle, drive and intermediate shafts. That's because Timken bearings are designed and manufactured to take the big loads from all directions of this machine cutting ¼" deep into work pieces of up to 40 tons. And they do it through a range of 22 speeds, giving rigidity with compact mounting and ease of assembly.

ON-THE-SPOT ENGINEERING SERVICE. Our sales engineers can help you right at the design stage to get the most economical bearing in terms of needed capacity and precision. Why not call them in early?

Industry rolls on

TIMKEN®

tapered roller bearings

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ontario.

CIRCLE 175 ON READER SERVICE CARD